


5 closed

		MP 3870 8311	
		BOOK NO.	ACCESSION
*352.5 Sa52r		16	257634
NOT TO BE TAKEN FROM THE LIBRARY			

Form No. 37-5M-9-24-C.P.

C

SAN FRANCISCO PUBLIC LIBRARY



3 1223 90187 2508

SAN FRANCISCO PUBLIC LIBRARY



3 1223 04140 4147

DOCUMENTS

Contains

FY 1915-1916

1916-1917

1917-1918

1918-1919

1919-1920

1920-21 & 21-22 IV

1922-23

1923-24



Digitized by the Internet Archive
in 2013

ANNUAL REPORT

OF THE

Bureau of Engineering
City and County of San Francisco

FOR THE

FISCAL YEAR ENDING JUNE 30, 1916

M. M. O'SHAUGHNESSY
CITY ENGINEER



x 352.5
Sa 52 n 16
237634

REPORT OF BUREAU OF ENGINEERING

FISCAL YEAR 1915-1916

San Francisco, July 1, 1916.

To the Honorable, the Board of Public Works,
of the City and County of San Francisco.

Gentlemen:—Herewith is transmitted the annual report of the Bureau of Engineering for the fiscal year 1915-1916.

In accordance with the policy of developing an adequate boulevard system with the greatest commercial and scenic possibilities, much work has been expended in improving main avenues for vehicle traffic.

Railroad Avenue has been paved and graded so that when the new pavement shortly to be constructed on Third Street is completed, it will be possible to travel through the Industrial district on a smoothly paved boulevard 100 feet wide from Third and Market Streets to the County line.

Negotiations for the Hunter's Point road have been advanced and specifications prepared. This thoroughfare should be constructed during the coming year.

Twin Peaks boulevard has been practically completed. This Avenue ascends on an easy grade to an elevation of 830 feet and encircles the Twin Peaks near their summits. From it is afforded a view of the City and its picturesque surroundings unequaled on the Peninsula.

On the North Bay shore, one section of Camino del Mar, extending from Fort Miley to Lincoln Park along the cliffs above Bakers Beach into the Presidio Reservation, has been completed. For this construction the Panama Pacific Exposition contributed \$56,000, and the City approximately \$30,000, for rights of way. An extension of this boulevard into the Presidio has been assured by the Federal government. It can then serve both as a military road, affording ready access between Fort Miley and the Presidio, and also as a scenic drive from which an unexcelled close view of the harbor entrance is obtainable.

The first unit of the Esplanade along the Ocean Beach has been completed and the second unit is well under way. When this Esplanade is extended for the total length of the Great Highway from the Cliff House to Sloat Boulevard, San Francisco's Beach will excel in appearance any of the ocean fronts for which Southern California is famous.

To correct some of the mistakes in our rectangular street plan, several excessive grades have been reduced, notably on Hayes Street, Cumberland Street, Collingwood Street and at Larkin and Francisco Streets. All of these thoroughfares were formerly practically unusable by vehicles but since being regraded are readily accessible.

During the past fiscal year more pavements have been constructed in San Francisco under public assessment than in any other single period of the City's history, including:

BUREAU OF ENGINEERING

Asphalt	381,523	sq. yds.	at cost of	\$730,541
Bituminous Rock	21,520	"	"	46,191
Basalt Block	18,814	"	"	64,434
Vitrified Brick	18,828	"	"	63,083
Broken Rock	29,173	"	"	22,692
Cobblestone	2,395	"	"	5,039
<hr/>				
Total	472,253	"	"	\$931,980

In June, 1915, bids were invited for furnishing and delivering track and special work for the Church Street Railway, including the material for laying tracks on Market Street. Since that date this line has been completed from Thirtieth to Sixteenth and Church Streets. The City Engineer recommended that an agreement be reached with the United Railroads pending the settlement of the City's right to tracks on Market Street, whereby the Church Street line could be placed in operation immediately upon completion. This recommendation was not acted upon by the Board of Supervisors, with the result that the tracks on Church Street will be idle for an indefinite period.

Contract has been awarded for the extension of the Potrero Avenue line from Twenty-fifth Street to Army Street, the estimated cost of the extension being \$10,000.

Bids were invited for furnishing steel rail for track through the Twin Peaks Tunnel, and contract has been awarded for the same.

Over 4300 feet of the Twin Peaks bore have been completed during the past fiscal year. The underground station at Laguna Honda is practically finished and only 4800 lineal feet remain to be completed. As the remaining portion contains no structural difficulties and is in a formation easy to excavate, it is expected that the entire tunnel will be completed before the end of the month of May, 1917.

A Strauss-Bascule bridge is being constructed across Channel Street waterway at Fourth Street, and the bridge over the channel at Third Street has been repaired, so that the newly developed industrial section to the east will be amply provided with avenues of approach.

Work on the main sewers during the past year was confined to the completion of Mile Rock Tunnel and Bakers Beach outlet; the construction of combined sewers in South Bay View District, Oakdale Avenue, San Bruno Avenue and Sloat Boulevard. In the Islais Creek District, a drainage channel was dug along the proposed route of a large reinforced concrete sewer, to reduce to a minimum the danger of floods from winter rains, from which some damage was done last winter.

Work on the Hetch Hetchy project has been materially advanced during 1915-1916. The 67-mile railroad extending from the junction of the Sierra Railway at Rosasco to Hetch Hetchy dam site, is being rushed and should be completed before next spring; a diversion tunnel, through which the Tuolumne River will be by-passed around the main dam site, has been finished; a large proportion of the timber needed for construction purposes has been prepared at the City's sawmill; roads have been built to all portions of the work; a power plant, at which will be generated the electricity for the various construction camps, is being built; the bottom of Hetch Hetchy reservoir has been cleared of timber so that it can be flooded during the coming winter, when the diversion dam, now under construction, will be completed.

Practically all of the application maps required in the Raker Bill have been filed. Application for power line location still remains to be made, but this will be done before December of the present year.

During the past fiscal year, the Department of Surveys established 2505 bench marks; made 1767 surveys for public and private contracts, street repairs, public buildings, etc.; made 40 surveys of lots for private owners; surveyed 6379 blocks and crossings, or a total of 692 miles. Fees collected and turned over to the City Treasurer by this department amounted to \$20,623.25.

Instruments have been added to the Engineering Testing Laboratory so that it is now one of the most completely equipped laboratories on the Pacific Coast. In it were tested samples of all material used in City construction, including asphalt, brick, cement, concrete, steel, iron, paints, oils, and water, the total number of tests for the year being 8329.

Following is a detailed report of the various divisions included in Bureau of Engineering.

Respectfully submitted,

M. M. O'SHAUGHNESSY,
City Engineer.

BOULEVARDS.

The economic value of an adequate system of boulevards has not been recognized in San Francisco until recent years. No large city in the United States was so poorly provided with road approaches, and the condition of the main thoroughfare, within the City itself, was not a matter of civic pride.

In outlining a Boulevard System, numerous factors had to be considered. Adequate approaches from the southern end of the Peninsula had to be provided, direct lines of communication between the principal districts of the City established, and suitable routes, from which the desirable features of the City could be viewed, had to be chosen.

Pursuant to the policy of developing to the utmost the City's commercial and scenic possibilities, the Boulevard System has recently been extended.

To provide for the manufacturing district, Railroad Avenue has been paved with asphalt and all excessive grades eliminated. This thoroughfare connects with San Mateo on the south by means of the San Bruno Road, on which paving is now almost completed as far as the County Line. On the north, Railroad Avenue joins with and practically merges into Third Street near the intersection of the latter thoroughfare with Islais Creek. Third Street will soon have a smooth pavement from this junction to its northerly terminus, so that it will be possible to travel through the industrial region on a smoothly paved boulevard 100 ft. wide from Third and Market Streets to the County Line. This route will materially shorten the distance to San Mateo.

Extending easterly from Railroad Avenue along Evans Avenue, a new roadway has been planned to reach Hunters Point drydock. The route will be along Evans Avenue as far east as Ingalls Street; thence on an easy curve to the intersection of Fairfax Avenue and Hawes Street; thence along the last named thoroughfare to Innes Avenue, which will form a portion of the roadway for a distance of four blocks to Donahue Street; thence along Donahue Street to Galvez Avenue, to Coleman Street; thence diagonally to Alvord Street, the entrance to the California Dry Dock Company's property.

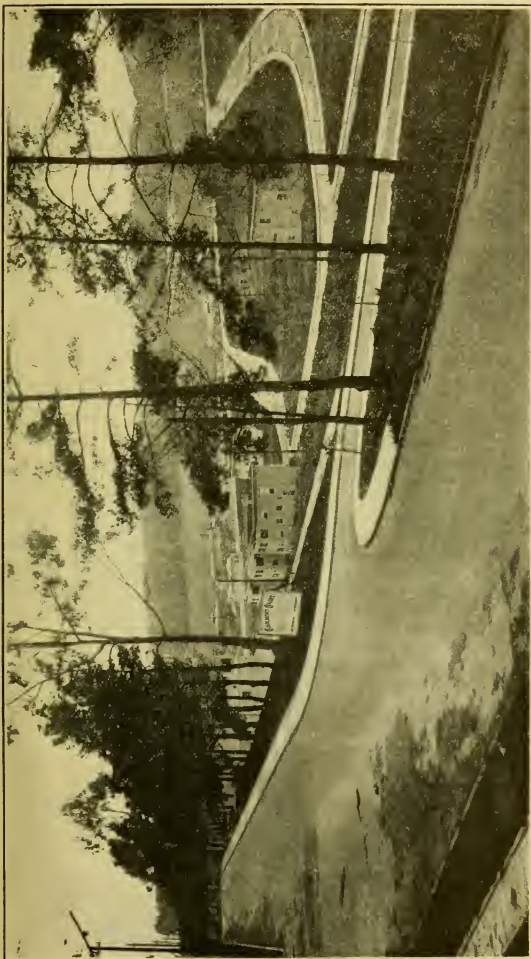
Specifications for the pavement of this roadway have been prepared and arrangements made by which the entire thoroughfare will shortly be constructed, the City paying a portion of the cost, and the remainder to be assessed to the owners of adjacent property.

For many years the industrial district, which will be served by this road, has been absolutely neglected, and many manufacturing enterprises have been forced to seek accommodations in transbay cities or further south along the Peninsula, because there were no adequate roadway approaches to the industrial sites along the east shore of the Bay, which is naturally a manufacturing district. Already the Union Iron Works is building a dock which will be 1,000 ft. long, 120 ft. wide, and cost over \$2,000,000, and reached by this roadway.

The Twin Peaks Boulevard now rapidly nearing completion, starts at the intersection of St. Germain and Burnett Avenues, ascends to and encircles near their summits, the two hills known as Twin Peaks at an elevation of 830 ft.; and thence descends to terminate in Corbett Avenue at a point about 900 ft. distant from the westerly boundary line of the San Miguel Rancho.

The roadway consists of an asphalt pavement 25 ft. wide with a 7 ft. 6 in. rock shoulder adjoining it on each side, giving a total width of 40 ft. The pavement is composed of a concrete base 6 in. in thickness, covered by a binder course 1½ in. thick and a 1 in. asphaltic wearing surface. Before constructing any pavement, the subgrade was thoroughly compacted by rolling with a 12-ton road roller.

Surface drainage is carried off by 12 in. corrugated steel culverts, encased in concrete, underlying the roadway at required points. Water collecting in side ditches is discharged into concrete inlets and thence through the culverts.



Portola Drive near West Portal of Twin Peaks Tunnel.

A guard rail consisting of two 2 in. by 6 in. surfaced pine rails nailed to 6 in. by 6 in. surfaced redwood posts 8 ft. apart was constructed in the shoulder adjoining the fill side of the roadway.

The contract for the construction of that section of the boulevard extending from St. Germain Avenue through the City Reservoir site was awarded on June 25, 1915, to Eaton & Smith for the estimated sum of \$24,058.

This portion of the boulevard is approximately 2,800 ft. long and its construction necessitated the excavation by steam shovel of approximately 30,000 cubic yards of rock and earth, the construction of 70,000 square feet of pavement and 2,730 lineal feet of guard rail.

The maximum grade on this section of the boulevard is 9% and the sharpest curve has a radius of 60 ft. The roadway on curves is super-elevated to insure safe and easy riding, the maximum super-elevation on the curve mentioned being 14 in.

One of the most notable features of this unit of the boulevard is a curve forming a full semi-circle or horseshoe with a center line radius of 68 ft. To eliminate accidents on this curve, 3,000 cubic yards of rock were excavated in the interior core within the horseshoe to give a clear and unobstructed view across the same.

Work under this contract was completed April 1, 1916, and the roadway thrown open to traffic immediately.

The contract for the second section of the Twin Peaks Boulevard extending from the City Reservoir site to Corbett Avenue was awarded on September 20, 1915, to F. R. Ritchie & Co. for the estimated sum of \$54,745.

This unit of the boulevard is about 7,900 ft. long, 6,820 ft. of same being built on an acquired right of way. The contract included the excavation of approximately 63,000 cubic yards of rock and earth and the construction of 202,121 square feet of pavement, 960 lineal feet of 12 in. culvert and 8,000 lineal feet of guard rail.

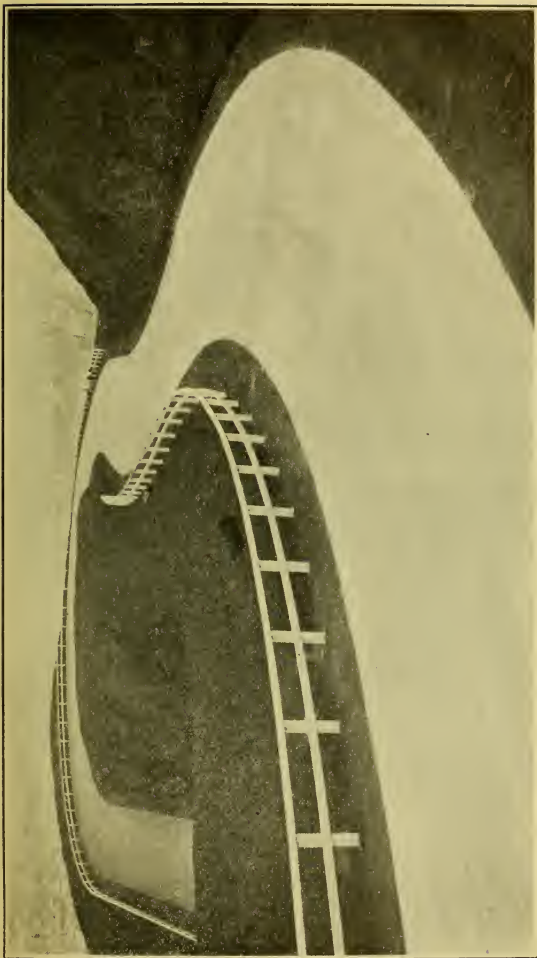
Excavation was performed by a steam shovel. For fills the excavated material was placed in the piles by means of scrapers and dump wagons and thence rolled in layers by a 12-ton road roller. One of the fills underlying the roadway is 60 ft. deep. The surface of the side hills underlying the fills was thoroughly plowed before placing any material for fill.

The maximum grade on this section is 9 per cent and the sharpest curve has a radius on the center line of 60 feet. The roadway has a uniform crown of $2\frac{1}{2}$ in. and it is super-elevated on all curves.

The boulevard encircles the two peaks at approximately the 825 ft. contour, giving a closed loop resembling the figure 8, the distance around same being 3,173 lineal feet.

A magnificent view of the City of San Francisco and surroundings may be obtained from any point on this loop. Work under this contract is now practically completed.

Another boulevard recently constructed is the Camino del Mar, extending from Fort Miley to Lincoln Park, along the cliffs above Bakers Beach into the Presidio Reservation near Lobos Creek, a length of 1,665 ft. This boulevard will serve as a military road, for which reason \$30,000 was donated by the Federal government for extending the same through the Presidio Reservation to connect with the McDowell Drive. Eventually the road will be extended to connect with the Marina on the north shore of the Bay, and from Fort Miley southerly to join the Ocean Beach Esplanade, the construction of which is described in detail later in this report. The Panama Pacific Exposition contributed \$56,000 for paving and the City \$30,000 for acquiring rights of way in this project.



Portion of Twin Peaks Boulevard.

From Camino del Mar, an excellent view of the inner bay and Marin hills is obtainable, and the picturesque scenery along the route is impressive alike to resident and tourist.

A portion of the boulevard system is now in course of construction along the Ocean Beach. Eventually the Esplanade will be extended as far south as the Sloat Boulevard and an additional road will lead from its terminus around Lake Merced. At the present, one section of the Esplanade protection wall is being constructed and the contract for the second section has been awarded.

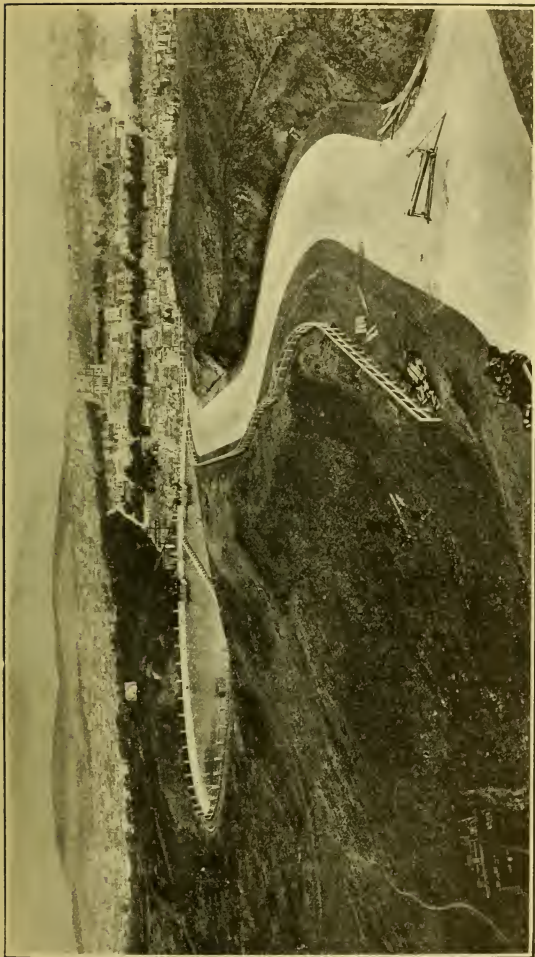
A scenic road around Telegraph Hill has been planned by the Bureau of Engineering and a small appropriation was requested of the Board of Supervisors which would enable the purchase of some of the lands necessary for its construction. Work on the Telegraph Hill Boulevard should be started during the fiscal year 1916-1917, which would permanently prevent the hill from the inroads of quarrymen.

Work will soon be started on the paving of Clarendon Avenue from Clayton Street southerly to connect these two completed sections around Twin Peaks with the already constructed boulevards leading southerly from Haight Street around Buena Vista Park.

Construction work has been completed on Plan No. 1 of the Market Street Extension, Corbett Avenue between 24th Street and the San Miguel Rancho. This consists of a 20 ft. roadway with two 7½ ft. shoulders, similar in construction to the Twin Peaks Boulevard described above.

The following tabulation shows the progress made on the principal units of the Boulevard System during the last fiscal year:—

	June 30, 1915	June 30, 1916
1 Junipero Serra Blvds.	Completed	
2 Sloat Boulevard	"	
3 Portola Drive	75% completed	Completed
4 Market Street Extension (Corbett Ave. Plan No. 1)	Proposed	
5 Market St. Extension (Plan No. 2)	"	Preliminary studies being made
6 19th Ave. Boulevard	Partly completed	Completed
7 Ocean Boulevard	" "	Finished save portion in Presidio, funds for which Congress recently appropriated
8 San Bruno Extension	" "	Completed
9 The Great Highway and Esplanade	Proposed improvement	Sect. "A" 500 ft. long 65% completed
10 Twin Peaks Blvd.	1st unit awarded	Both units completed
11 Hunters Point Blvd.		Proposed
12 Telegraph Hill Blvd.		"
13 Marina Boulevard		"
14 Twin Peaks Extension		"
15 Clarendon Ave., Clayton to St. Germain		Contract awarded



View of Richmond and Sunset Districts from Twin Peaks Boulevard.

BERNAL CUT.

As outlined a year ago, this improvement is badly needed but its acquisition will have to be deferred until provision has been made to finance the purchase of right of way and cost of construction work.

OCEAN BEACH ESPLANADE.

The first section of Ocean Beach Esplanade now under construction on the west shore of the City just south of the Cliff House by J. D. Hannah, Contractor, was started January 10, 1916. The structure is planned primarily for beach protection, having a front wall formed by driving interlocking concrete piling to depth of 13 ft. below extreme low tide. These piles were precast, are 10 in. thick, 4 ft. wide and 20 ft. long and when in position form a reinforced concrete curtain wall 10 in. thick extending north and south. 28 ft. to the east of this outer line of sheet piles are located pedestal piles 18 in. square with 3 ft. square bulb and $24\frac{1}{2}$ ft. in length and spaced at 10 ft. centers. Between these two rows of piles are placed heavy reinforced beams 20 in. by 43 in. by $27\frac{1}{2}$ ft. weighing 13 tons, which form the main ties, and by means of keyways support the intermediate slabs of concrete. These beams are placed on 20 ft. centers except at stair sections where they are at 10 ft. centers. The space between beams is concreted to form a heavy reinforcing slab, 5 bleacher seats and 3 stringers for additional support. The stringers have a cross section 16 in. by 18 in. The entire section between the beams has a solid bearing on sand and 18 in. of packed clay. The minimum thickness of this bleacher section is 12 in. The last bleacher riser develops into a rollway and this rollway ends at top of and forms part of a $3\frac{1}{2}$ ft. parapet wall with returns at either side of each stairway section. Behind the parapet is a 20 ft. sidewalk with scrupper holes to release wave water, and 6 in. concrete curb and gutter.

Over the front row of sheet piles is a heavy reinforced concrete slab 4 ft. thick and 6 ft. wide which caps the piles and forms a main support for lower ends of beams and intermediate slabs. At the upper end of beams, bearing on pedestal piles is a similar cap which ties the upper portion of slab and structure together. Expansion joints are provided and likewise drinking fountains and electric light connections.

All sheet piles, H beams and pedestal piles were precast, allowed to season for 40 days and then put into position. Most of the precast work was done on the bank above the beach and hauled to position on cars over a construction track. Some were cast on the beach and handled directly by derrick. All piles were driven by 4 water jets and steam hammers.

Two jets of 2 in. pipe reduced to $\frac{3}{4}$ in. at discharge end were used on each side of sheet piles and one at each corner of bulb on pedestal piles and in both cases were so located that they discharged about $1\frac{1}{2}$ ft. below the bottom of pile.

Water for jetting was supplied by the Olympic Salt Water Co. under static pressure of 130 pounds and nozzle pressure of 40 pounds per jet. Consumption of water by jetting process was approximately 100 cubic feet per minute. The steam hammer was made useful by the fact that the summer beach level is 8 ft. above required grade on sheet piles, and if placed to required grade by jets, it would be impossible to interlock the next pile. Therefore, 10 or 11 sheet piles were placed to sand grade and then with hammer and jets were driven to the required grade, one sheet pile always remaining at sand level to start next pile. Pedestal piles were jetted to required grade without the use of hammer. All jetting was accomplished without very great difficulty. Floating boulders, especially at the north end of the contract, gave some trouble, making it necessary to excavate 8 feet to winter beach level and then remove boulders.

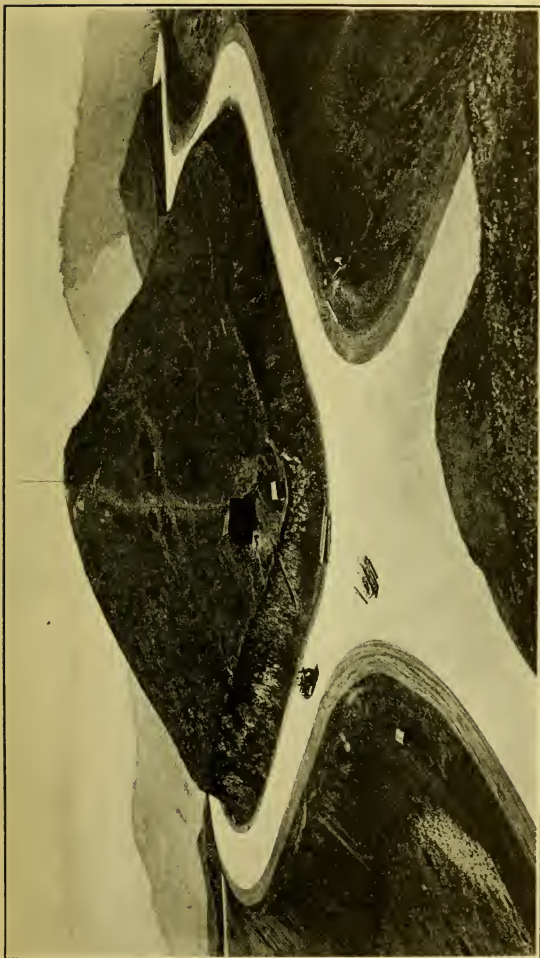


Figure 8 on Twin Peaks Boulevard.

On all precast work the concrete mix was 1-1½-3. The concrete on balance of work will be 1-2-4, the same being used throughout.

At present the driving of all piling is complete, H beams are in place and graded, and sheet piles poured. Bleacher section forms are in place and tamping of sand and clay under bleacher slab is in progress. Over 250 lineal feet of bleachers have been poured. Contract will be completed with the possible exception of sidewalk and backfill by August 1.

Contract for the second unit of the esplanade was awarded in July, 1916, to J. D. Hannah for \$23,148.90. This provides for an addition of 170 lineal feet of structure identical with that described above, so that by November 1, 1916, 670 ft. of structure will be completed. It is to be hoped that in the forthcoming budget enough money will be appropriated to complete this deserving project as far south as the chalet pile structure built some years ago.

REGRADES.

On account of the excellent landscape views obtainable from their slopes, some of San Francisco's hills are extremely desirable as residence sites. Unfortunately, however, little thought was given to topography by the surveyor who first laid out the City in 1848. One set of streets was run parallel to the meridian, and another at right angles thereto. The fact that this gridiron plan would later necessitate grades as steep as 55 per cent on some streets and thereby greatly detract from the value of adjoining property, apparently was overlooked until many years later.

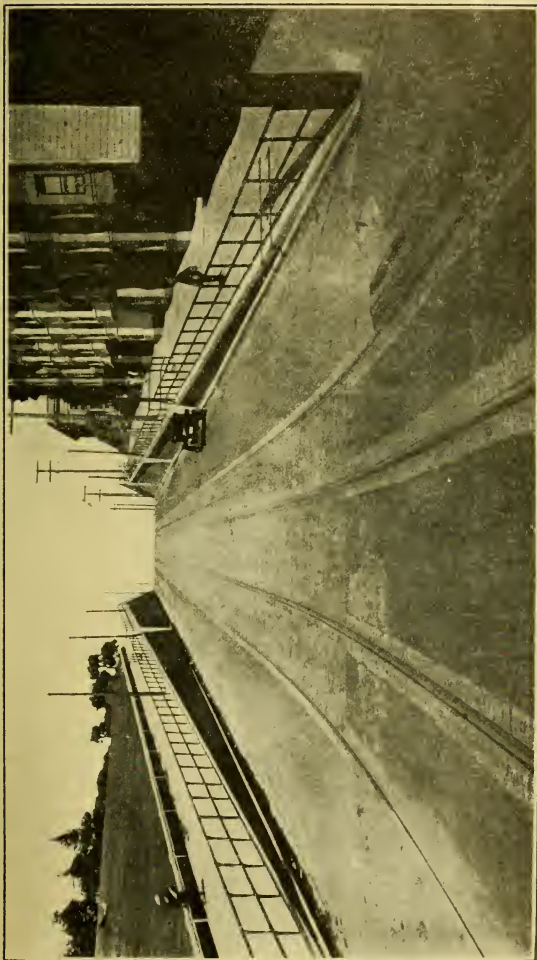
To eliminate, at a minimum cost, as many as possible of these excessive grades has been the policy of the City Engineer's office. No standard plan has been adopted to suit every grade, but a separate study is made of each case, and the improvement best adapted thereto recommended.

At the request of the property owners affected, the grade of Larkin Street between Chestnut and Francisco Streets has recently been reduced from 29 per cent to a maximum of 16 per cent. The cost of this improvement is being paid by the owners having frontage on the streets to be regaded. On Larkin Street \$16.31 per front foot will be assessed against the property on each side of the street, and on Francisco Street the rate will be \$20.29 per front foot. Present property values on both these streets are now in the neighborhood of \$115 per front foot. The regrade will advance this value to over \$250.

For a width of 28 ft. the east side of Larkin Street between Chestnut and Francisco Streets has been cut down to descend on a uniform 16.07 per cent grade. On this incline is an 18 ft. vitrified brick roadway and a 10 ft. artificial stone sidewalk. This strip is separated from the west side of the street by a reinforced concrete retaining wall, and near the bottom of the hill turns westward into the southerly side of Francisco Street. The west side of Larkin Street has been graded to a higher elevation than the east side, and descends on grades varying from 4.37 to 10.92 per cent, for a distance of 157.5 ft., where its vitrified brick roadway 28.25 ft. wide terminates in a parked slope. At its termination the west roadway is 12 ft. higher than the east roadway directly opposite. The sidewalk continues down the west side in a series of steps to the level of the easterly strip at Francisco Street.

Turning westerly, the steeper strip continues to descend on a 16 per cent grade along the south side of Francisco Street for a distance of 127.5 ft., separated from the north side of the street by a reinforced concrete retaining wall. Around the westerly end of this wall the roadway turns through 180 degrees, descending easterly along the north side of Francisco Street on a 3.6 per cent grade, back to Larkin Street, into which it turns northerly.

By this detour a roadway suitable for automobile traffic has been provided from the North Beach District to the higher levels on the south, and some very



Hayes Street Regrade.

desirable hillside home sites, now inaccessible and undeveloped, opened for immediate settlement.

Contract for this construction was awarded to F. Rolandi at an estimated cost of approximately \$30,000. The construction will be completed in the immediate future.

The entire expense of this work is being paid for voluntarily by the property owners, without any appeal to the municipal treasury. They co-operated with this office in the most friendly manner to adjust the problems connected with this work.

HAYES STREET REGRADE.

This improvement has recently been completed and consisted of cutting the roadway down between curb lines for a maximum of 15 ft., thereby establishing a 10.909% grade between Scott and Pierce Streets in lieu of the 14.54% grade previously existing, and lowering the intersection of Pierce and Hayes Streets an average of 14 ft. Retaining walls at the curb lines form the sides of the cut, stairways being provided at intervals connecting the street with the sidewalks on the upper level. Sewers and public service pipes were placed under the sidewalks. The Hayes Street electric car line which formerly detoured at Fillmore Street to reach the district west of this regrade now continues directly over Hayes Street through the new cut, effecting considerable saving in time and power. On this work 11,500 cubic yards of excavation was done by the Street Railway Company while the City paid \$16,000 for the balance of the improvement.

Bids are about to be received for the improvement of Cumberland Street, Sanchez to Noe Streets, and Sanchez Street, 19th to 20th Streets, and proceedings have been started for the improvement of Leavenworth Street, Chestnut to Hyde Street.

Collingwood Street, 20th to 22nd Streets, and 21st Street and 22nd Street between Castro and Diamond Streets, are to be treated shortly to improvements that will tend to make accessible this very precipitous district.

Other projects of a similar nature are:—

Bartol Street, Vallejo and Broadway, Kearny and Montgomery Streets;
Caselli Avenue, Falcon and Eagle;
Caselli Avenue, Clayton, Corbett, Mars.

MUNICIPAL RAILWAYS.

CHURCH STREET ROAD

Article XII of the new Charter of the City and County of San Francisco which became effective January 8, 1900, declares it to be the intention of the people that its public utilities shall be gradually acquired and ultimately owned by the City and County of San Francisco.

With particular regard to the ownership and operation of its street railway system, this policy may be considered to have been ratified by the people when on December 30, 1909, at a special election they voted \$2,020,000 of bonds for the construction of the Geary Street Railway, the franchise for the old Geary Street Cable Road having expired in 1903. With this money the Geary Street Municipal Railway was constructed and operation from Kearny Street to the Beach and Park commenced on December 28, 1912; on June 24, 1913, operation was extended to the Ferries.

The Panama-Pacific Exposition a little later made imperative the immediate expansion of the Municipal Railway System to provide transportation to and from the fair grounds. The site selected for the Exposition, while ideal in some

respects, was somewhat inaccessible and presented a serious problem in the matter of street transportation. The only lines running anywhere near the Exposition were the Fillmore Hill and the Polk Street Lines of the United Railroads and the Union Street Line. The exposition directors, City officials and Railway officials were impressed with the need for action and gave the matter early and serious consideration. In addressing the Board of Supervisors on the subject on February 5, 1913, C. C. Moore, President of the Exposition Company, said: "I do not think we are saying too much when we say that the burden of supplying adequate street railway transportation to the Exposition belongs to the City and not to us. We want to tell you how desperate this is, how utterly and completely inadequate the present facilities are. * * * With no street car facilities to the Exposition Grounds our \$100,000,000 structure, built by our pride and our patriotism, so far from fruition, will be a sad thing to contemplate."

At the same meeting, Mr. Mullaly, Exposition Director, and Vice President of the United Railroads, stated most emphatically that "The United Railroads will not build one foot of additional street railroad under present charter conditions."

Confronted with these conditions, upon the request of the Directors of the Panama-Pacific International Exposition, the Board of Supervisors by resolution directed the Board of Public Works to have the City Engineer submit plans and estimates of cost of a Municipal Railway System designed to furnish to the Panama-Pacific Exposition an adequate street railway service and at the same time form a nucleus for a desirable Municipal Railway System.

In accordance with this resolution the City Engineer on April 5, 1913, submitted to the Board of Public Works for transmittal to the Supervisors, a report upon the extensions of Municipal Railways to provide transportation for the Panama-Pacific International Exposition. Acting upon this report, the question of a bond issue of \$3,500,000 for constructing the lines recommended therein was submitted to the people and overwhelmingly carried at an election held August 26, 1913.

The subsequent program of prompt and efficient construction under the supervision of this department—all work being completed on time—provides a unique exhibit of municipal efficiency.

The Exposition has since passed into history, but it is of interest to review a few of the figures bearing upon the attendance and the transportation that it may better be appreciated how necessary these lines were to the success of the Exposition and how well the demands were met.

The total attendance at the Exposition for the 288 days was 18,875,974. It is estimated that at least 50 per cent of this number was handled on the Municipal lines, representing approximately \$1,000,000 in fares due to the Exposition traffic alone.

The greatest attendance for any single day was on closing day, December 4, when 458,558 people attended the Exposition. The Municipal Railway receipts on this day were \$16,748.20, representing 334,964 cash fares; or in other words, 36½ per cent of the total attendance rode both ways on the Municipal lines.

The second largest day was San Francisco Day, the attendance being 348,372, the railway receipts \$13,922.75, or 40 per cent of the attendance both ways.

The third largest day was opening day, 255,149, when the railway receipts were \$13,299.70, or 52 per cent of the attendance. All of these days were holidays and practically all of the business handled by the roads was Exposition traffic. The reduction of the percentages as the attendance of 255,000 was exceeded, indicates that the capacity of the lines was practically reached on these three days that the crowds were not comfortably handled. The pre-Exposition estimate was that there would be at least one day in excess of 250,000 attendance.

The total Municipal Railway receipts for the Exposition year were \$2,255,841.15 to apply to interest, depreciation and reserves. It is interesting to note

that this surplus represents practically the total cost of the track construction for the Exposition extensions.

Of all the lines provided for under the 1913 Bond Issue the Church Street line was the only one not completed for service prior to the opening of the Exposition.

An examination of the Journal of the Board of Supervisors will reveal the extent and bitterness of the controversy aroused at the time that the construction of this road was up for consideration. Briefly, the history of this Church Street controversy which was the cause for the delay in the construction of this line, is as follows:—

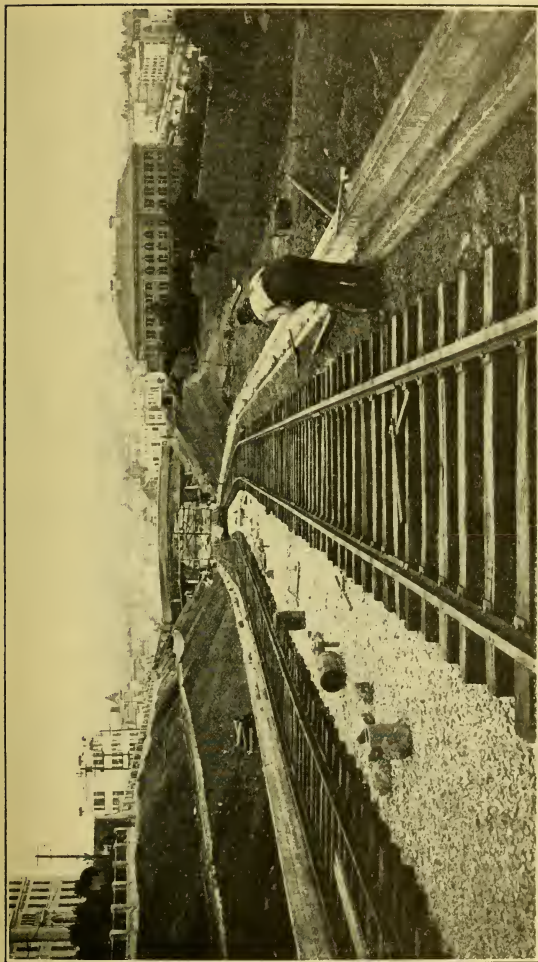
The City Engineer recommended that the Church Street line be diverted from Church Street through Mission Park and a private right of way acquired from 18th to 22nd Sts., for the purpose of making a detour to overcome the extreme grade of 19.3 per cent on a direct route over Church Street between 20th and 21st Streets. In connection with this diversion it was planned also to open a street along the railroad grade for the accommodation of vehicular and pedestrian traffic, the cost of opening this street to be paid for by an assessment on the property benefited. The assessment feature aroused a storm of protest from a number of the affected property owners.

In an endeavor to effect a solution of this Church Street problem satisfactory to all interests, some nine comprehensive studies were made by the City Engineer, including, by an order of the Board of Supervisors, the preparation of complete plans and specifications for a cable operated road over the hill. After protracted discussion by the Board of all the possible solutions, which lasted for eighteen months, on February 8, 1915, the Supervisors passed an ordinance empowering the Board of Public Works to authorize the City Engineer to prepare plans, specifications and contracts and advertise for bids for furnishing necessary material for constructing the Church Street extension of the Municipal Railway System and approving the plan for overcoming the grades between 18th and 22nd Streets by a diversion through Mission Park and private property between 20th and 22nd Streets. This plan, as finally approved, follows closely the original recommendation of the City Engineer as to location, but the right of way was narrowed to 28 ft. and is without provision for pedestrian or vehicular traffic. Under pressure of the protestants organized as the Church Street Non-Assessment League, the Supervisors agreed that the City would assume the expense of opening the railroad right of way, thereby adding something over \$150,000 to the charges against the railroad construction.

By comparing the finally adopted plan with the tunnel project suggested in Arnold's report, Page 278, which would have cost \$100,000 more to execute and be less desirable for use, the City is to be congratulated on the final outcome and much well deserved credit should be given to Messrs. Ransom and Eckart of this office for their intelligent zeal in furthering this work.

Acting upon the ordinance authorizing the construction in June, 1915, bids were invited for furnishing and delivering the track special work for the Church Street Line, including the track special work for laying outer tracks on Market Street. The question of purchasing this material for the outer tracks on Market Street was put up to the Supervisors, but no decision was reached until December 1, 1915, when the Board of Public Works was authorized to purchase all of the materials for the Church Street Line except those for the outer tracks on Market Street from Van Ness Avenue to Church Street.

Contracts were awarded for constructing one section of the Church Street Line from 18th to 22nd Streets, and another section from 16th to 18th Streets and from 22nd to 30th Streets. Both of these contracts have been completed prior to July, 1916, but owing to a controversy with the United Railroads and an injunction, the City has been unable to connect its Church Street tracks with the other tracks of its system. The City Engineer's office had previously taken



Grade for Detour on Church Street Railroad.

this matter up and agreed with the engineers of the United Railroads on the valuation of the tracks between Market Street and 16th Street on Church Street, which tracks formed a part of the Church Street Line under the original plan. Arrangements also were made with the United Railroads by which connection would be made with the United Railroads tracks on 16th Street at Potrero Avenue and at Church Street for the purpose of permitting temporary routing to and from the Potrero Avenue car barn from the Church Street tracks, the City paying the United Railroads a nominal charge for current and wear and tear on the track and overhead. Pending the settlement of the question of the City's right to lay tracks on Market Street, the United Railroads agreed to an exchange of transfers at Church and Market Streets. These arrangements, which offered a temporary solution for the operation of the Church Street Road, were never consummated owing to the refusal of the Board of Supervisors to allow the exchange of transfers at Church and Market Streets on a 40-60 basis, that is, redeeming Municipal transfers for three cents from the United Railroads and allowing the United Railroads to redeem their transfers to Church Street on a two cent basis. This interchange was recommended by the City Engineer's office as being equitable based on the ratio of the lengths of the lines involved, the Church Street line being approximately 9,000 ft. against 14,000 ft. operated by the United Railroads on Market Street.

In order to precipitate matters and bring the questions into court for a final settlement of all the questions involved, the City commenced the installation of the outer tracks on Market Street at Van Ness Avenue on June 12, 1916, but were stopped from proceeding by an injunction secured in a Federal Court. This matter is still in the courts at the present time and it will probably be several years before it is finally settled as both the City and the United Railroads are determined to carry the matter to the highest tribunal.

In the meantime, a second contract for purchasing track special work for the Market Street section of the Church Street Line has been awarded to the United States Steel Products Company, which provides that the City may order this material at any time within a period of one year or abandon the contract, so that whenever this matter is settled favorable to the City, work can proceed immediately on the construction of the track.

Owing to the complex proposal connected with the Church Street work, it is interesting to recite the different public proceedings incident to the successful completion of a portion of this work:—

CHURCH STREET LINE—MUNICIPAL RAILWAYS

Connection between Van Ness Avenue and Church Street.

June 29, 1914—Resolution directing Board of Public Works to prepare plans and specifications for the construction of the Church Street Line from Market Street and Van Ness Avenue to Dorland and Church Streets to 30th and Church Streets, and that the construction of this unit be proceeded with as soon as possible, owing to difficulty in getting satisfactory plans for portion between 22nd and Dorland Streets.

Motion introduced; laid over 3 weeks.

Aug. 3, 1914—Above motion reported on adversely by Public Utilities Committee and refused passage, 10 to 6.

Dec. 21, 1914—Ordinance authorizing Board of Public Works to prepare plans and specifications and contracts, and advertise for bids for material for constructing the Municipal Railway along Market to Church Street and along Church Street to the northerly line of 18th Street. Introduced by Vogelsang; referred to Public Utilities Committee.

- Jan. 4, 1915—On motion of Supervisor McCarthy, consideration of ordinance laid over 2 weeks; 13 to 4.
- Jan. 19, 1915—Ordinance authorizing construction of Church Street Line from Van Ness Avenue out Market Street to 18th and Church Streets; brought up and made special order of business for the following Thursday at 3 P. M.
- Jan. 21, 1915—J. R. 1626, introduced by Power, requesting City Engineer to present estimate of cost of Church Street road, utilizing United Railroads trackage now in place on Market and Church Streets; carried unanimously.

Ordinance authorizing Board of Public Works to prepare plans and specifications for the construction of the Church Street extension from Van Ness Avenue and Market Street to 18th and Church Streets, indefinitely postponed on motion of Supervisor Vogelsang.

- Jan. 25, 1915—Motion introduced by Supervisor Power requesting United Railroads to advise Board of Public Works to enter into agreement with City for use of Market Street tracks; lost 8 to 8.
- Feb. 1, 1915—Report of City Engineer dated January 27, 1915, showing estimate of cost of constructing Church Street Line, recommending that authority be given the Board of Public Works to immediately advertise for bids for furnishing material and labor necessary to construct the Church Street extension from Van Ness Avenue and Market Street to 30th and Church Street, and recommending that the Board of Supervisors pass a resolution indicating whether they desire that additional tracks be constructed outside of the United Railroads tracks on Market Street from Van Ness Avenue to Church Street or to use the United Railroads tracks on this street.

Thereupon Supervisor Vogelsang presented a bill directing the Board of Public Works to prepare plans and specifications for the construction of the Church Street extension. Passed to print.

- Feb. 8, 1915—Ordinance authorizing Board of Public Works to advertise for bids for constructing the Church Street road from Van Ness Avenue and Market Street to 30th and Church Streets; adopted 11 to 6.

J. R. 1662 introduced by Vogelsang, authorizing Mayor and City Attorney to enter into negotiations with the United Railroads for the joint use of tracks on Market Street. Carried unanimously.

- June 19, 1915—Board of Public Works invited bids for furnishing and delivering track special work for the Church Street line, including track special work for outer tracks on Market Street from Van Ness Avenue to Church Street.
- June 26, 1915—Board of Public Works called for bids for furnishing and delivering steel rails, rail fastenings and joints for the Church Street Line.
- July 9, 1915—Letter from City Engineer to the Board of Public Works recommending that the question be submitted to the Supervisors and a decision obtained from them as to whether or not it is their intention to have outside tracks constructed on Market Street.
- July 22, 1915—Recommendation of City Engineer to award contract for track special work and advising contractor not to execute work until policy settled.

- July 27, 1915—Letter from City Engineer to Board of Public Works awarding contracts for various materials and recommending contract be held up pending settlement by the Supervisors as to the question of constructing outer tracks on Market Street.
- Sept. 20, 1915—Communications from the City Attorney and Mayor relative to negotiations with the United Railroads for the use of the Market Street tracks, indicating that no agreement was probable.
- Dec. 1, 1915—Approximately, Public Utilities Committee, Board of Supervisors, authorized purchase of all materials not actually involved in constructing outer tracks on Market Street.
- Dec. 7, 1915—Report of City Engineer to Public Utilities Committee suggesting three possible solutions for operation on Church Street Road.
- Jan. 3, 1916—Bill No. 3907 authorizing submission of an offer to United Railroads for purchase of west of Twin Peaks Tunnel Line with provision for interchange of transfer at Church and Market, etc. Recommitted to Public Utilities Committee.
- Apr. 3, 1916—Resolution No. 12,772 (new series) accepting offer of United Railroads for use of tracks on 16th Street from Potrero Avenue to Church Street. Accepted. Passed 17 votes.
- May 1, 1916—Resolution No. 12,887 directing Board of Public Works to proceed with construction of outer tracks from 16th and Church Streets to Van Ness Avenue and Market Street. Adopted. 17 votes.
- May 2, 1916—United Railroads refuse to allow installation of track crossing at 18th and Church Streets.
- May 4, 1916—Conference Mayor Rolph, Judge Sullivan, M. M. O'Shaughnessy, N. A. Eckart; decision made to install 18th Street crossing on Saturday afternoon and Sunday.
- Apr. 29, 1916—Section "C" of Church Street Line completed.
- May 13, 1916—Commenced installation of crossing at 18th and Church Street at 1 P. M.; in place ready for operation of United Railroad cars Sunday morning.
- May 14, 1916—Connected up rails of Section "C" with crossing.
- May 18, 1916—Letter withheld from Board of Public Works.
- May 19, 1916—N. A. Eckart in consultation with Mayor Rolph relative to installation of crossing at Van Ness Avenue and Market Street.
- June 9, 1916—Conference, Mayor Rolph, Judge Sullivan, George Lull, M. M. O'Shaughnessy, N. A. Eckart, relative to installation of tracks on Market Street and laying foundation for suit.
Decided to install crossing at Van Ness Avenue and Market Street on June 12.
- June 12, 1916—Resolution of Board of Public Works authorizing City Engineer to construct outer track on Market and Church Streets by day labor.
1 P. M. commenced opening street to install crossing.
- June 13, 1916—Enjoined from further work.
- June 28, 1916—Section "B" track work completed.
- July 21, 1916—Contract No. 81 for installation of trolley wires completed and road ready for operation except connection with United Railroads.
- Aug. 22, 1916—Judge Hunt (U. S. Circuit Court) commenced hearing of case.
- Aug. 25, 1916—Completed hearing of case. Fixed October 10 as date for submission of final briefs of United Railroads in rebuttal.

In the last annual report mention was made of the proposed extension of the Municipal Railway across Golden Gate Park from 10th Avenue and Fulton Street to 14th Avenue and Judah Street, the plans and specifications for which road at that time were approximately 90 per cent completed. Upon the completion of these plans, they were submitted to the Board of Park Commissioners in November, 1916, with the request that the Park Commissioners give their consent to the construction of this line in accordance with the plans prepared. This request was met with absolute refusal and with the counter-suggestion that if the Park was to be crossed it should be in the vicinity of 20th Avenue and then in a subway or tunnel. The cost of such a tunnel being in the neighborhood of \$800,000 was of course absolutely prohibitive and warranted no consideration. Following upon this action by the Park Commissioners, the Board of Supervisors passed a resolution directing the Board of Public Works to immediately proceed with the construction of the line across the Park in accordance with the plans prepared under the original ordinance. This resolution was vetoed by His Honor, Mayor Rolph, and later failed of securing the necessary votes to pass over the Mayor's veto. Immediately prior to vetoing the resolution, the Mayor called a conference of the Park Commission and representatives of the Supervisors and the City Engineer in an endeavor to reach some solution. At this conference the Park Commission remained firm in their stand to oppose the construction of the Golden Gate Park Line between 10th Avenue and Fulton Street and 14th Avenue and Judah Street, but offered as a compromise to permit a surface crossing at 20th Avenue, the crossing to follow the City Engineer's plans as developed for the original location. Due to the excessive outlay involved for this 20th Avenue route, the loss of earnings from the missing patronage of the music stand region the desirability of its construction now may be well questioned if the funds are available. The construction of the line across Golden Gate Park is at present in a somewhat anomalous condition. There is an ordinance authorizing and directing the Board of Public Works to construct this line between 10th Avenue and Fulton Street and 14th Avenue and Judah Street and the City Attorney has held that the Supervisors have the authority to order the construction of this line across the Park regardless of the opposition of the Park Commission provided that such road does not interfere with the free use of the Park for park purposes. Eminent attorneys, on the other hand, question this and nothing but a Court decision can absolutely determine the question. In view of this it is doubtful if any line will be built across the Park for some time to come.

In conjunction with the extension of Potrero Avenue south this office has recommended, and the Board of Supervisors have authorized, the construction of an extension to the Potrero Avenue Line from 25th Street, at the present terminus, to Army Street, the estimated cost of the work being \$10,000. This short extension was determined on in view of the fact that, by constructing the track in advance of the pavement, a saving of approximately \$2,500 would be effected in the ultimate cost of the Potrero Avenue extension by avoiding the necessity of tearing up new pavement to lay tracks. Contracts for furnishing the track special work have already been awarded and contracts for the track work will be let at such time as to permit of the track being laid following the completion of the heavy excavation.

Upon the recommendation of this office the Supervisors have appropriated \$275,000 from the surplus earnings of the Municipal Railway System for the purpose of constructing the track and overhead work through the Twin Peaks Tunnel from 17th and Market Streets to the junction of Sloat and Junipero Serra Boulevards. The ordinance authorizing this construction also provides for a connection from the west portal of the Twin Peaks Tunnel out Taraval Street to the Ocean Beach. The additional money necessary for completing this portion of the line has not as yet been appropriated. Bids have been invited for furnishing the steel rail for the track work through the tunnel and other contracts

will be let at such times as may be necessary to provide for the completion of the Twin Peaks Line at the earliest date the progress of the tunnel will warrant.

The City Engineer has on several occasions orally and in written reports advised the Board of Public Works and Supervisors of the necessity of preparedness in having adequate transportation facilities arranged so as to reap the fullest benefit to the City immediately on the completion of the \$4,000,000 Twin Peaks Tunnel. San Francisco is suffering from lack of adequate rapid transit to the outlying sections, and while the problem is involved and complex, the City authorities have shown so much constructive ability in the past four years in overcoming other obstacles that it is hoped some immediate attention and consistent effort will be given to this pressing subject.

The street railway situation in San Francisco presents a number of serious problems. The track mileage in the City is more than five years behind the needs of the present population. It is difficult to extend the street railway facilities logically or economically because of the fact that all of the railway lines are not under a unified control. The City cannot force the United Railroads to make any extensions nor will the United Railroads make any extensions of their own volition under existing Charter conditions. Many extensions are at present desirable but without suitable connections or transfer arrangement with both the Municipal Railway and the United Railroads system would be of little real benefit. The more carefully the situation is studied the more urgent appears the necessity for the unification of control of all the existing railroad lines, and until this has been accomplished San Francisco will have to put up with a more or less inadequate transportation system. This office at the present time is studying the problem and expects to make a report shortly outlining a logical program for future extensions of the existing Municipal Railway System, but at the best the construction of these extensions will fall short of solving the transportation question in San Francisco, for the solution of this problem requires consideration on broader lines.

The time is fast approaching when a rapid transit system must be considered. This would be either of subway or elevated type, preferably the latter, at this stage of our development, the comparative costs being about \$800,000 a mile for the elevated as against \$3,500,000 a mile for the subway construction. The first link in a rapid transit system naturally should parallel Market Street connecting with the Twin Peaks Tunnel and with a branch extending south through the Mission in the vicinity of Capp Street.

STATEMENT OF 1910 GEARY AND MARKET STREETS BOND FUNDS.

EXPENDITURES.

Prior to July 1, 1915.....	\$1,948,602.05
From July 1, 1915, to July 1, 1916:	
Ferry outer loop on Embarcadero, Lower Market Street	\$ 2,058.50
Car Barn Extension, Geary Street Railway Tank and Tower Foundation	645.20
Carn Barn, Second Story, Geary Street Railway.....	29,170.57
Carn Barn—Construction Tank and Tower.....	1,482.00
Carn Barn Construction—Completing Heating System	341.14
Extra Parts and Equipment.....	423.93
Plans and specifications.....	306.35
	<hr/>
Total during last fiscal year.....	\$ 34,427.69
	<hr/>
Total to date.....	\$1,983,029.74
Available for future expenditures.....	43,282.16
	<hr/>
Total sale of bonds, miscellaneous sources and unsold bonds	\$2,026,311.90

STATEMENT OF 1913 RAILWAY BOND FUND.

EXPENDITURES.

Prior to July 1, 1915.....		\$3,122,731.82
From July 1, 1915, to July 1, 1916:		
Auto Truck and Tower for Trolley Repair.....	\$ 2,165.00	
Bending Rails, Church St. Railway.....	791.27	
Church St. Railway, 18th to 22nd St.	93,371.79	
Concrete Trolley Poles Reinforced, for Church Street Railway	6,404.41	
Concrete Trolley Poles, Division St., Potrero to Bryant St.	238.00	
Copper Rail Bonds, Church St. Railway.....	2,975.10	
Electrical Conductors, Church St. Railway.....	5,853.31	
Header Blocks	135.37	
Incidentals other than extras.....	119.89	
Inspection of Railways—Church Street Extension.....	8,095.34	
Inspection of Railways—Construction and Extension	1,008.90	
Lands—Supervisors' Expenditures	263.04	
Machine Shop Equipment, Pipe Yard.....	1,325.39	
Plans and Specifications Church Street Railway.....	3,370.66	
Plans and Specifications for Municipal Railways.....	10,777.09	
Church St. Railway—Condemnation of Rights of Way	956.90	
Church St. Railway—Drilling Test Holes in Private Rights of Way	199.00	
Division St., Bryant to 10th Sts., Re-arrangement Fire Dept. Stables.....	8,738.54	
Hydrants, Church St. Right of Way, 18th to 22nd Sts.	200.00	
Lockers in Car Barns, 17th St. and Geary St.	2,820.00	
Rails, Joints, Fastenings and Spikes, Account No. 2, Church St. Railway.....	38,323.67	
Unloading and Storing Railway Material.....	2,104.81	
Sand Bins in Car Barns, Steel.....	1,760.00	
Tie Plates, Church St. Railway.....	1,539.75	
Track Special Work.....	4,264.00	
Work for Municipal Railway.....	6,706.64	
Ties, Redwood, Church St. Railway.....	4,889.60	
Church St. Railway, 16th to 18th and 22nd to 30th Sts.	56,734.03	
Car Bodies	21,750.00	
Carn Barn, 2nd Story, Geary St. Railway.....	243.00	
Total during last fiscal year.....		\$ 287,824.50
Amount available for further contracts.....		148,683.48
Total receipts for sale of bonds and miscellaneous sources		\$3,569,039.80

STREET PAVEMENTS.

With the marvelous increase in the yearly output of motor-driven vehicles, from the light touring car to the extra heavy auto truck, capable of transporting extraordinary loads, there has grown a constant demand for more and better street construction, to be able to withstand this new and more severe type of traffic. Highway Engineering has therefore grown to be one of the most important branches of Municipal Engineering. The passage of workable highway laws, like the Street Improvement Act of 1911, amended in 1915, as recommended by the City Engineer, makes possible the construction of a large number of street pavements that were practically impossible under the old street improvement acts, on account of the prohibitive method of assessment. The remarkable increase in the number of street assessment contracts over previous years, is due in a large measure to this very moderate plan of assessment, under the new law, the payments of which can run from 1 to 10 years, thus putting an otherwise prohibitive street improvement within the reach of the property owners of small means.

Between July 1, 1915, and June 30, 1916, more pavements were constructed under public assessment than in any other single year in the City's history. This year has also been conspicuous for the introduction of modern creosoted wood block pavement and the replacement of the obsolete cobblestone pavement by modern first class vitrified brick surfaces. Rough kiln marked type vitrified brick has been used extensively on steep grades. The practical elimination of the waterbound macadam has also been accomplished. This past year has also seen the construction of the first concrete pavement built under City supervision. It is hardly possible, however, that with the present remarkably low price of asphalt pavement, namely, \$1.35 per square yard, that this type will ever be extensively used here, except in outlying districts.

Granite curb is gradually being displaced by armored concrete curbs, at a reduction in cost of about 50 per cent, and a distinctive gain in the matter of appearance.

With the advent of the creosoted wood block pavement, and the already increasing quantity of vitrified brick pavement, practically all of the most modern types of pavement are now in use in San Francisco, each in the location to which it is best adapted.

The pavement diagram which follows shows graphically the increase in quantity and popularity of the sheet asphalt type of pavement. The suitability and low cost of construction is the reason for the remarkable increase. Specifications for all types of pavements constructed here insure street surfaces that compare favorably with those of the other large American cities, and in the case of the asphalt, the pavements constructed with this material here are unsurpassed by the same type of surface anywhere in the United States.

Table No. 2 gives a summary of the cost and quantity of street improvements constructed during the fiscal year under the supervision of the City Engineer.

Considerable improvement has been made during the year in the method of handling the office work in regard to street improvements, all the forms being standardized and filed under a specially designed card system, the greatest improvement in this line being made in the matter of keeping cost data on street improvements. Instead of the cumbersome book form, special cards have been made whereon all this data is entered. The new cost sheets give the segregated costs for different thickness of surface, binder course and base.

The appended photographs show some of the standard types of pavement actually constructed in the City, with a brief explanation regarding their important features of construction.

Type of Pavement, Vitrified Brick (rough kiln marked) and Asphalt.

Location of Improvement, Eighth Avenue between Lawton Street and Moraga Street.

Length of Block, 600 ft.

Width of Side Strip, 20 ft.

Width of Street, 70 ft.

Width of Center Strip, 20 ft.

Width of Roadway, 40 ft.

Date of Acceptance, March 2, 1914.

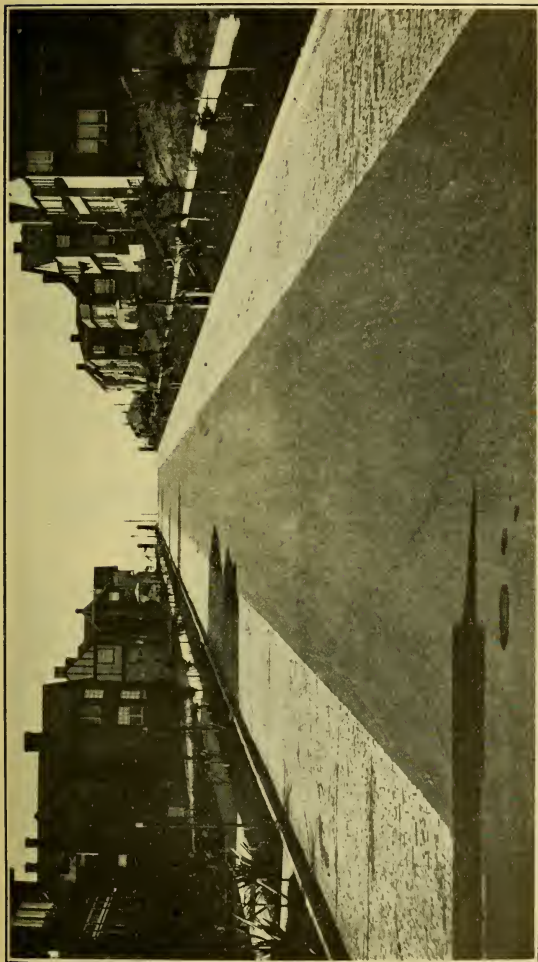
CONSTRUCTION DATA.

Side Strip—

Kind of Base, Cement Conc.	Thickness, 6 in.	Proportions, 1:2½:7
" " Cushion, Sand	" 1½ in.	
" " Filler, Cement		
" " Surface, Vit. Brick		

Central Strip—

Kind of Base, Cement Conc.	Thickness, 6 in.	Proportions, 1:2½:7
" " Surface, Bit. Rock	" 2 in.	



Eighth Avenue between Lawton and Moraga Streets.

Type of Pavement, Creosoted Wood Block.

Location of Improvement, Battery Street between Bush and Pine Streets.

Length of Block, 275 ft.

Width of Street, 68 ft. $2\frac{3}{4}$ in.

Width of Roadway, 40 ft. $4\frac{3}{4}$ in. Date of Acceptance, Previously Accepted.

CONSTRUCTION DATA.

Kind of Base, Cement Conc.	Thickness, 6 in.
" " Cushion, Sand	" $\frac{1}{2}$ in.
" " Filler, Tenex Asphalt	"
" " Surface, Asph. & Pea Gravel	" $\frac{1}{4}$ in.



Battery Street between Bush and Pine Streets.

Type of Pavement, Vitrified Brick.

Location of Improvement, Pierce Street from Jackson to Pacific Street.

Length of Block, 275 ft.

Width of Side Strip, none.

Width of Street, 68 ft. 9 in.

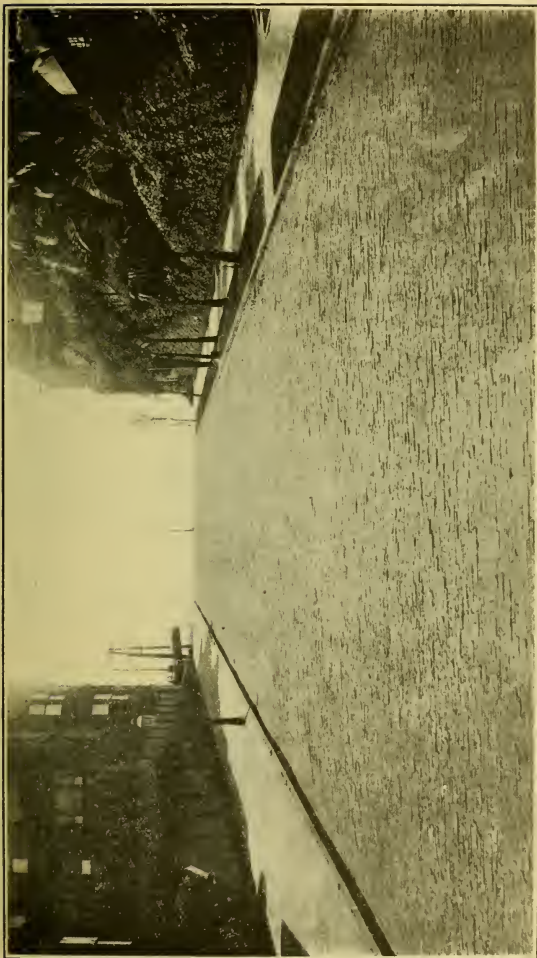
Width of Center Strip, none.

Width of Roadway, 38 ft. 9 in.

Date of Acceptance, January 22, 1914.

CONSTRUCTION DATA.

Kind of Base, Cement Conc.	Thickness, 6 in.	Proportions, 1:2½:7
" " Cushion, Sand	" 1½ in.	"
" " Filler, Cement	"	" 1:1½
" " Surface, Brick	" 4 in.	"



Pierce Street from Jackson and Pacific Streets.

Type of Pavement, Sheet Asphalt and Basalt Block Gutters.

Location of Improvement, Geary Street between Stockton and Powell Streets.

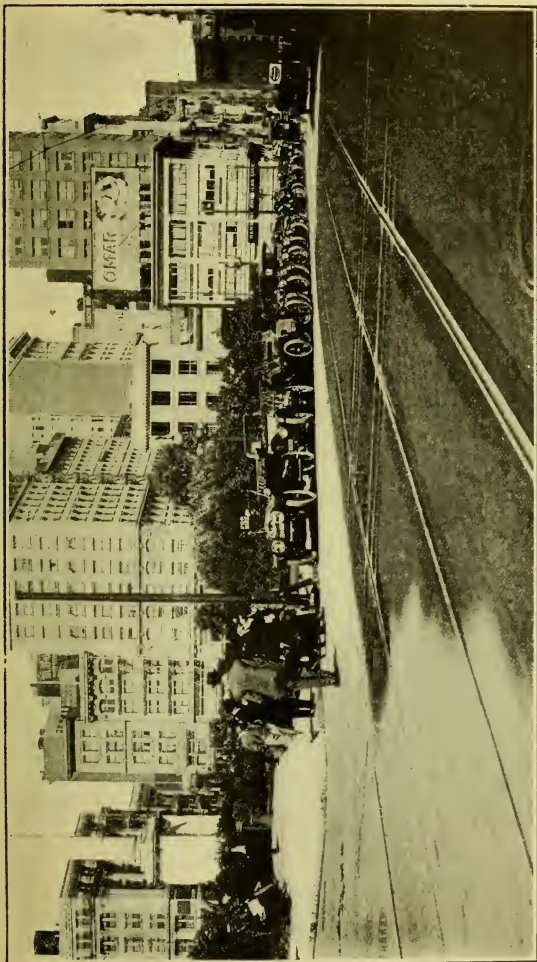
Length of Block, 412 ft. 6 in. Width of Side Strip, 11 ft. 7 in. and 17 ft. 4 ½ in.

Width of Street, 68 ft. 11 ½ in. Width of Center Strip, Double Electric Track 16 ft.

Width of Roadway, 44 ft. 11 ½ in. Date of Acceptance, Previously Accepted.

CONSTRUCTION DATA.

Kind of Base, Cement Conc.	Thickness, 6 in.	Proportions, 1:3:7
" " Cushion, None	"	
" " Filler, None	"	
" " Surface, Asphalt, Top	" 1 ½ in.	
Binder	" 2 in.	



Geary Street between Stockton and Powell Streets.

Type of Pavement, Asphalt and Basalt Block.

Location of Improvement, Thirty-sixth Avenue—Geary Street to Clement Street.

Length of Block, 600 ft.

Width of Side Strip, 13 ft.

Width of Street, 70 ft.

Width of Center Strip, 14 ft.

Width of Roadway, 40 ft.

Date of Acceptance, March 6, 1914.

CONSTRUCTION DATA.

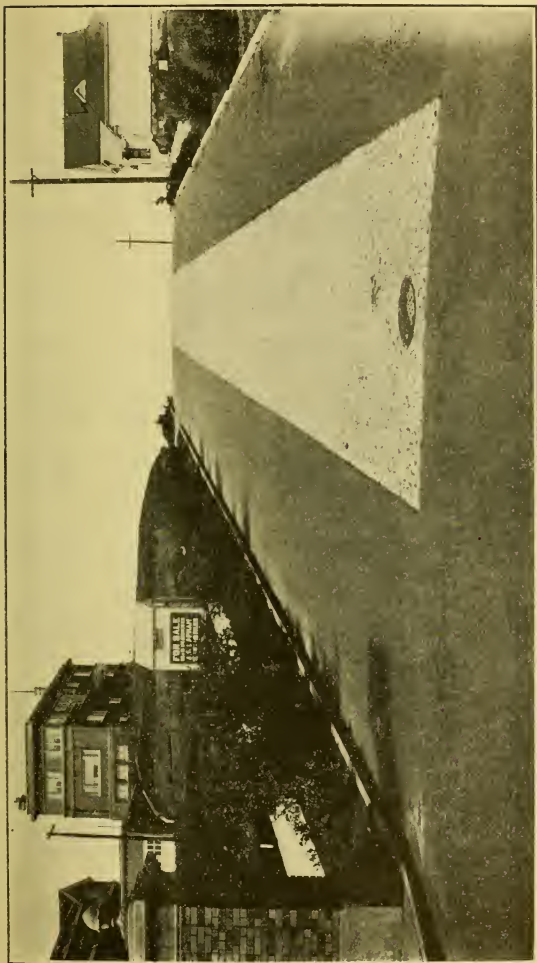
Central Strip—

Kind of Base, Natural Soil Rolled	Thickness,
" " Cushion, Sand	" 5 in.
" " Filler, Gravel and Coal Tar Cement	"
" " Surface, Basalt	" 7 in. to 7 ½ in.

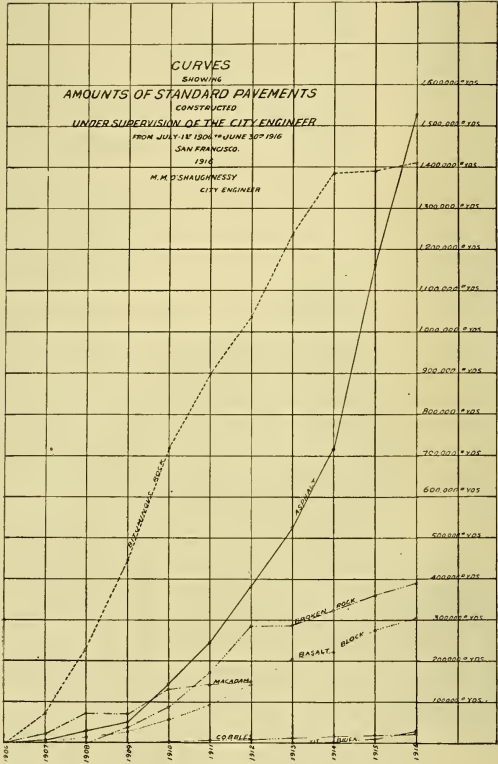
Side Strip—

Kind of Base, Cement Conc.	Thickness, 6 in.	Proportions, 1:2 ½ :7
" " Surface, Asphalt	" 2 in.	

Also Full Width for 400 ft.



Thirty-sixth Avenue—Geary Street to Clement Street.



AMOUNT AND COST OF STREET WORK—PRIVATE.

FISCAL YEAR ENDING JUNE 30, 1916.

	Quantity	Cost
Asphalt (6" Concrete Base)—	Sq. Yds.	
W. S. 1½" Binder 2".....	332.55	\$ 1,196.89
W. S. 2"	140,627.42	306,108.06
W. S. 2½"	765.33	1,653.26
W. S. 1" Binder 1½"	1,416.66	3,187.50
Bituminous Rock (6" Concrete Base)—		
W. S. 2"	20,974.70	\$ 44,965.75
Basalt Block (on Sand)—		
Gravel and Asphalt Filler.....	1,106.34	\$ 3,186.27
Gravel Filler	1,144.11	3,693.77
Vitrified Brick—		
Kiln Marked or Hillside.....	3,402.61	10,338.16
Asphalt with Basalt Block Strip—		
Asphalt W. S. 2".....	21,459.55	45,407.72
B. B. with Gravel Filler.....	9,062.34	29,777.49
Bituminous Rock with Basalt Block Strip—		
Bitumen W. S. 2".....	544.44	1,225.00
Basalt Block Gravel Filler.....	272.22	1,102.50
Asphalt with Vitrified Brick Strip—		
Asphalt W. S. 2".....	16,564.40	34,853.39
Brick, Kiln Marked or Hillside.....	8,258.30	28,494.54
Bituminous Rock with Vitrified Rock Strip—		
Broken Rock	20,823.95	15,498.48
Cobbles	1,404.88	3,160.98
Broken Rock Walks.....	2,995.55	2,250.68
Curbs—		
Granite, New	24,157.35	30,284.11
Granite, Reset	314.39	62.49
Granite, Redressed and Reset.....	94.40	18.88
Concrete	75,427.40	59,821.20
Redwood	6,611.14	2,717.09
Gutters—		
Basalt Blocks	302.50	2,158.03
Concrete	116.95	526.30
Walks—		
Artificial Stone	8,420.67	10,080.04
Grading—	Cu. Yds.	
Cut	86,248.82	50,024.32
Fill	65,273.20	16,318.30

AMOUNT AND COST OF STREET WORK—PRIVATE—Continued.

	Quantity Lineal Ft. and No.	Cost
I. S. P., 6" Diameter—		
Side Sewer	1,515.29	\$ 1,464.35
I. S. P., 8" Diameter—		
Pipe	12,501.07	26,555.82
Y Branches	720	817.45
I. S. P., 12" Diameter—		
Pipe	12,922.37	22,871.44
Y Branches	449	546.50
I. S. P., 15" Diameter—		
Pipe	3,490	7,586.26
Y Branches	143	218.50
I. S. P., 18" Diameter—		
Pipe	5,843.52	16,630.92
Y Branches	668	1,631.00
I. S. P., 21" Diameter—		
Pipe	240	720.00
Y Branches	8	32.00
Manholes—		
New	145	11,039.50
Catch Basins—		
New	168	10,526.00
Reset	12	500.12
Storm Water Inlet.....	2	60.00
I. S. P., 10" Diameter—		
Culvert	4,940.72	7,109.00

AMOUNT AND COST OF STREET WORK—PUBLIC.

FISCAL YEAR ENDING JUNE 30, 1916.

	Quantity	Cost
Asphalt (6" Concrete Base)—	Sq. Yds.	
W. S. 2"	111,618.87	\$199,027.12
W. S. 1" Binder 1½"	4,079.24	5,874.11
Basalt Block (on Sand)—		
Gravel Filler	878.71	3,404.39
Basalt Block (6" Concrete Base)—		
Gravel and Asphalt Filler.....	1,033	3,718.40
Vitrified Brick—		
Kiln Marked or Hillside.....	273.84	649.56
Asphalt with Basalt Block Strip—		
Asphalt W. S. 2".....	14,186.16	27,417.13
B. B. with Gravel Filler.....	4,020.33	14,794.32
Asphalt with Vitrified Brick Strip—		
Asphalt W. S. 2".....	15,988.50	28,705.26
Brick, Kiln Marked or Hillside.....	5,732.00	20,012.43
Bituminous Rock with Vitrified Brick Strip—		
Broken Rock	8,348.90	7,193.83
Cobbles	637.26	1,433.84
Broken Rock Walks.....	1,135	871.80
Curbs—		
Granite, New	20,921.01	24,210.22
Granite, Reset	396.17	247.58
Granite, Redressed and Reset.....	112.33	2.25
Concrete	38,162.70	26,644.00
Redwood	977.50	264.50
Gutters—		
Basalt Blocks	362.53	1,607.72
Artificial Stone Walks.....	24,001.94	30,786.17
Grading—	Cu. Yds.	
Cut	131,835.92	76,707.56
Fill	43,849.47	16,258.76
I. S. P. 6" Diameter—	Lineal Ft. and No.	
Side Sewer	4,646	3,794.50
I. S. P. 8" Diameter		
Pipe	12,804	23,144.06
Y Branches	886	844.95
I. S. P. 12" Diameter—		
Pipe	6,700.89	14,363.16
Y Branches	322	332.75

AMOUNT AND COST OF STREET WORK—PUBLIC—Continued.

	Quantity Lineal Ft. and No.	Cost
I. S. P. 15" Diameter—		
Pipe	2,705.96	\$ 4,454.35
Y Branches	101	143.31
I. S. P. 18" Diameter—		
Pipe	1,604.58	3,122.96
Y Branches	192	390.10
Manholes—		
New	134	14,726.00
Catch Basins—		
New	228	14,019.50
Reset	1	40.00
I. S. P. 10" Diameter—		
Culvert	7,269.88	7,189.79

AMOUNT AND COST OF STREET WORK—CITY PAY.

FISCAL YEAR ENDING JUNE 30, 1916.

	Quantity	Cost
Asphalt (6" Concrete Base)—	Sq. Yds.	
W. S. 2".....	17,578	25,043.31
W. S. 1" Binder 1½".....	32,569.14	45,462.83
Basalt Block (6" Concrete Base)—		
Gravel Filler	589.11	1,802.68
Vitrified Brick—		
Kiln Marked or Hillside.....	169.11	553.73
Asphalt with Vitrified Brick Strip—		
Asphalt W. S. 2".....	4,337.03	6,604.11
Brick, Kiln Marked or Hillside.....	992.14	3,035.09
Bituminous Rock with Vitrified Brick Strip—		
Cobbles	352.34	443.96
Curbs—		
Granite, New	7,084	5,883.43
Granite, Reset	696	93.50
Granite, Redressed and Reset.....	1,247	120.09
Concrete	4,480.18	1,681.59
Gutters—		
Basalt Blocks	42.80	188.76
Artificial Stone Walks	15,371.03	13,512.19
Grading—	Cu. Yds.	
Cut	15,053.39	17,534.81
I. S. P. 6" Diameter—	Lineal Ft. and No.	
Side Sewer	158	126.40
I. S. P. 8" Diameter—		
Pipe	50	75.00
I. S. P. 12" Diameter—		
Pipe	510	861.00
I. S. P. 18" Diameter—		
Pipe	271	496.00
Y Branches	3	3.00
Manholes—		
New	7	585.00
Catch Basins—		
New	16	649.20
I. S. P. 10" Diameter—		
Culvert	1,571	1,302.49

TWIN PEAKS TUNNEL.

The general engineering features of Twin Peaks Tunnel were described in the report of the City Engineer for the fiscal year 1913-1914. The project has been advanced efficiently and economically and all of the serious construction problems encountered so far have been solved satisfactorily.

The close of the fiscal year 1914-1915 found the contractor at Station 8 + 10, some two hundred feet underground at the west end; with 25% of Laguna Honda Station excavated; the vent shaft in the Relief Home Tract fairly well started and the subway section completed on the easterly end. Practically 4,300 feet of completed tunnel has been constructed during the 1915-1916 fiscal year.

An obstruction, presenting some difficulty and successfully handled, occurred about 1800 feet from the west portal. A brick lined water duct of the Spring Valley Water Company constructed in 1865 crossed at a sharp angle 8 feet above the tunnel arch. It was conveyed by means of a by-pass over the completed tunnel. A shaft was sunk, the water duct tapped by a 30" pipe, which ran west 275 ft. in a drift previously driven, crossed the tunnel at right angles and connected with the original duct again. Later the water was permitted to follow the original course. The entire section of tunnel between the west portal and the Laguna Honda Station has been completed.

Excavation for Laguna Honda Station and 22 ft. of tunnel section on each end was done in open cut, the maximum depth being 70 ft. Steam shovels carried the cut to within 15 ft. of rail grade, the sides of the pit being retained by piles. Trenches were then dug by hand for the side walls and footings of the station, after which the concreting was done and then the core of earth was removed. The waste material, a sandy clay, hauled an average distance of 1/3 mile in motor trucks, was used in filling low portions of the valley in which the station is built. Station is completed except the superstructure.

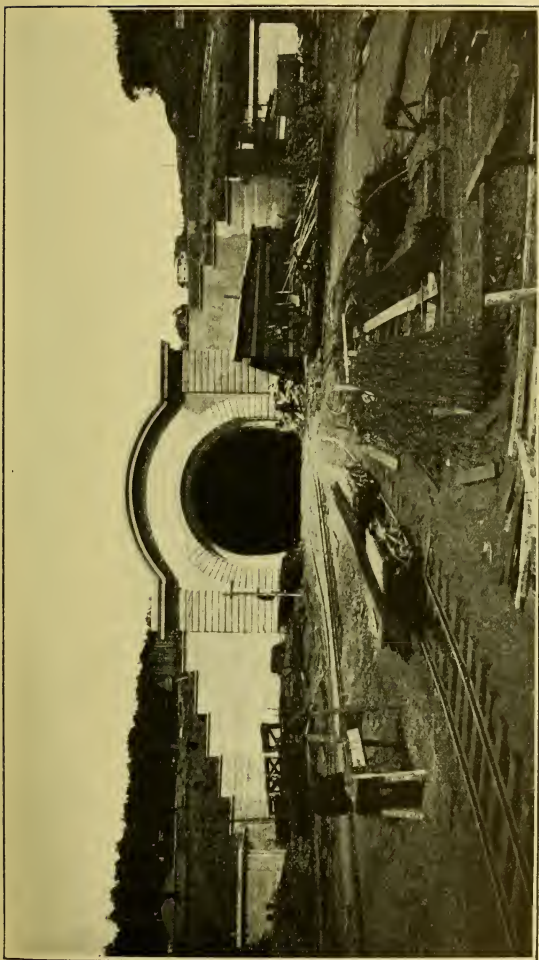
Because of an ascending grade, excavation between the vent shaft and the Laguna Honda Station was started from the former. The shaft when completed will have an inside diameter of 13 ft. but the excavation was made 20 x 32 ft. so as to take in full width of tunnel section and to permit of construction of forms for concreting. From the bottom of this shaft, 100 ft. deep through water bearing sand and timbered with piles held by 12 x 12 bracing and walings hung with steel hangers, a drift was carried 300 ft. westerly at invert grade through sandstone, when it broke through the sandstone into a waterbearing sand, causing 300,000 gallons per day to be lifted out at the shaft. Another drift was then started and kept in the sandstone until after the sand deposit was passed, when the second drift was brought up to line with the first one. Easterly from Laguna Honda tunneling has been projected over 414 ft. on the descending grade toward the vent shaft, the drift previously driven draining the ground penetrated. Concreting follows within free working distance of the finished timber lining.

Excavation for that section between the east portal and a point 500 ft. southwesterly therefrom, was done between two rows of piles and heavy timbering with the necessary cross braces. This ground was a filled in creek bed and the 30,000 cu. yds. of excavation was removed by pick and shovel. This portion of the tunnel has been constructed and the backfilling finished.

Adjacent to the section just described or at Station 97 + 15, the tunneling proper on the east end was started and was driven westerly to Station 87 + 63, leaving to be completed those portions between Station 46 + 57 and 87 + 63 and between Station 46 + 37 and 39 + 00 or 4,843 lineal feet, together with the superstructure of Laguna Honda Station.

In the light of the progress made during the past fiscal year when so many adverse conditions were encountered, and the fact that the greatest portion of the work remaining to be done is in rock, there is not any apparent reason to question the forecast that April, 1917, will see the east and west facings meet and the tunnel completed.

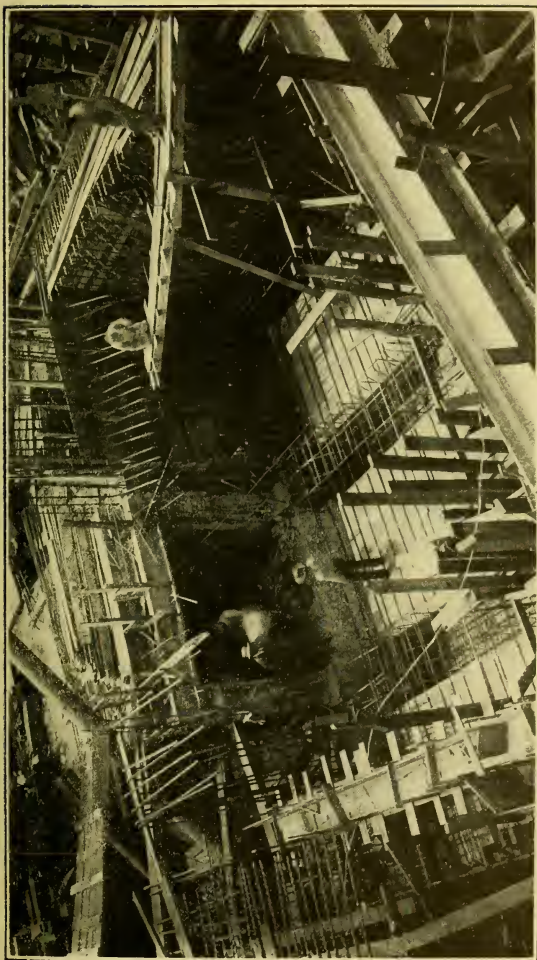
R. C. Storrie & Company, to whom this contract was awarded, for the estimated sum of \$3,372,000, have performed work the estimated value of which to date is \$2,168,539.38.



West Portal, Twin Peaks Tunnel.

TABLE 1—ALIGNMENT, GRADES AND SUBDIVISIONS

		Grade		Distance on		Curve
		Ascend	Descend	Tangent	Curve	To Radius
West Approach Tunnel Section	0-00 to 0-83	.015		83.000		
	0-83 to 17-27.26	.015		1,644.260		
	17-27.26 to 30-31.44	.015			1304.183	Right 5,729.65
	30-31.44 to 30-73	.015		41.557		
Laguna Honda Sta.	30-73 to 33-73		.03	300.000		
	33-73 to 34-30.10		.03	57.103		
	34-30.10 to 36-60.10		.03		230.003	Right 5,729.65
	36-60.10 to 47-13.00		.03	1,052.894		
Ventilating Sta. Tunnel Section Taper Connection 29' 6" Tunnel Sect.	47-13 to 47-26.00		.03	13.000		
	47-26 to 98-64.00		.03	5,138.000		
	98-64 to 100-44.00		.03	180.000		
	100-44 to 100-74.00		.03	30.000		
	100-74 to 103-76.81		.0287	302.816		
	103-76.81 to 104-96.23		.0287		119.420	Right 1,555.49
	104-96.23 to 108-52.73		.0287		356.500	Right 1,017.95
Eureka Valley Sta. Subway Section	108-52.73 to 109-72.15		.0287		119.420	Right 1,555.49
	109-72.15 to 111-45.76		.0287	173.610		
	111-45.76 to 114-45.76		.0140	300.000		
	114-45.76 to 114-85.61		.0140	39.850		
	114-85.61 to 117-33.56		.0140			
	117-33.56 to 117-38.76		.0140	5.200	247.950	Left 861.37
East Approach	117-38.76 to 119-25.76	.0424		187.000		
				9,548.290	2377.476	



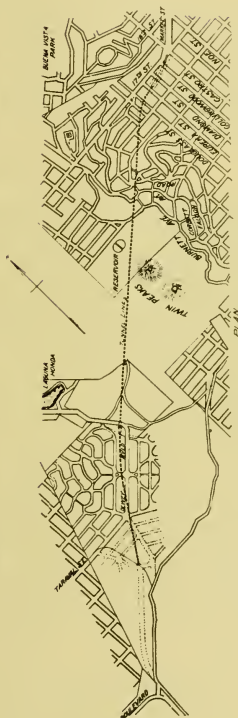
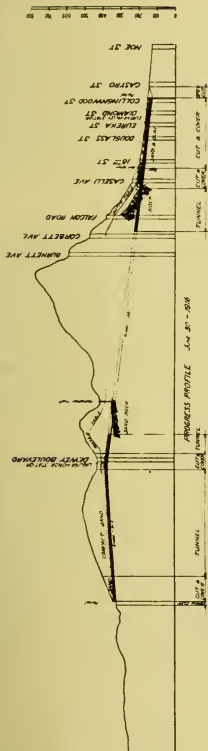
Constructing Laguna Honda Underground Station. The floor will be 62 feet below the ground surface.

Table II sets forth the progress made on these subdivisions during each of the two fiscal years just passed, and the work still to be performed. The profile pictures this progress:—

TABLE II—ANNUAL PROGRESS.

Subdivision	Method	Station		Completed Prior to June 1915	Lineal Feet		Grand Total
		From	To		Completed June 30, 1915, to June 30, 1916	To be Compl.	
West Approach	Open Cut	0+00	0+83	83			83
“ Portal		100% completed					
Tunnel Section	Cut and cover	0+83	5+61	478			478
“ “	In tunnel	5+61	8+10	249			249
		8+10	30+61		2251		2251
		30+83	30+61		22		22
Laguna Honda	Cut and cover	25%		*75			75
“ “ Sta.		55%			*165		165
“ “ “		20%				*62	62
Tunnel Section	Cut and cover	33+85	34+07		22		22
“ “	In tunnel	34+07	39+00		493		493
“ “		39+00	46+37			737	737
Vent Shaft	Cut and cover	10%		*2			2
“ “		90%			*18		18
Tunnel Section	In tunnel	87+63	46+57			4106	4106
“ “		97+15	87+63		952		952
“ “	Cut and cover	98+65	97+15		150		150
Taper Connect.		100+45	98+65		180		180
29' 6"		100+75	100+45		30		30
18th Street Vent. Shaft		100% completed					
Subway Section	Cut and cover	111+46	100+75	1071			1071
Eureka Valley Station		114+46	111+46	300			300
Subway Section		117+38	114+46	292			292
East Portal	Open cut	100% completed					
East Approach		119+25	117+38	187			187
Totals.....				2737	4283	4905	11,925

* Equivalent in feet.



GENERAL PLAN AND PROFILE

Scale: 1" = 100'

0 40 80 120
Feet

BRIDGES.

THIRD STREET BRIDGE.

The earthquake shock of 1906 disturbed the south abutment of the Third Street Bridge and since that time there has been a gradual movement of the south abutment with its superimposed south leaf, toward the north.

In April of 1915, a contract was let for altering this bridge and a pile bulkhead was driven in the south approach. Recently the bridge bound again in the middle at the junction of the two leaves and further alterations were made which will permit of cutting the juncture plates from time to time until 12 in. have been removed. In view of the fact that 17 in. is the total recorded distance the abutment has shifted since 1907, and the various alterations have replaced worn members, there is every reason to believe that, with the occasional cutting of the juncture plates, the bridge should stand considerable service.

FOURTH STREET BRIDGE.

The construction of a Strauss Bascule Bridge across Channel Street Waterway at Fourth Street, has been in progress since August, 1915. Six weeks' delay in starting was occasioned by repair work on the Third Street Bridge, which prevented closing of operation of the old drawbridge at Fourth Street.

The Thomson Bridge Company has the general contract to furnish all material and install the bridge and approaches. Sub-contracts for the fabrication of the structural steel and making and installation of the machinery have been let to the Ralston Iron Works and the Joshua Henry Machine Company, respectively, by the Thomson Bridge Company.

The first work started at the bridge site was the wrecking and removal of the old drawbridge superstructure and the precasting of the concrete piles for the deck approach foundations.

Pile foundations and concrete for the seawalls at the extreme shore ends of the approaches were then placed.

Progress of the construction depended on the placing of the cylinders that form the bridge seats which are on the north side of the channel. Before this work could be started the channel had to be cleared by removing the pile foundation of the old bridge, the piles of the protection work of the drawbridge, and innumerable old snags of piles of old construction that had broken off and rotted. A clamshell dredger was used to clear the channel up and down stream from the center cluster forming the old drawbridge foundation. In order to remove the piles of the cluster to a point below the official channel bottom level, blasting was resorted to and, to be effective, a steel cage guide was used to keep the powder near enough to the pile. This work occasioned considerable delay, as the caissons for the cylinders are placed by a floating driver which had to operate at the obstructed points.

Work of placing the caissons for the cylinders started in January. Two caissons forty feet in length were driven and excavated to a level close to the point proposed for starting the pile foundations. The foundation material of sand and clay was unable to resist the water pressure from outside of the caissons and they "blew in", filling with water. Both caissons were then lengthened, reset and driven, but the same trouble was experienced as before, with the addition that one caisson partially collapsed.

The other caisson was further lengthened and heavily reinforced and successively used in placing the ten cylinders on the north side. These cylinders have a ten foot diameter concrete base ten feet high, resting on twelve piles driven to a firm bearing, the cylinder then extending up to the bridge seat as a 4 foot

diameter reinforced concrete shaft. Four cylinders are tied together with a five foot reinforced concrete slab to form the seat of each trunnion bearing.

Unusual rainy weather during January and February was the cause of great delay in placing the cylinder.

At the present time the work completed for the north side has been the placing of foundations for trunnion towers, deck approaches and seawall; the placing of most of the forms and reinforcing steel for the deck approaches and the trunnion towers and portals for the superstructure.

For the south side the seawall and concrete pile foundations for the deck approach are in place and the pile foundation for one cylinder driven. Only three cylinders are required on the south side, as the bridge, a single leaf bascule, operates from the north side.

In the near future the concrete deck for the north side will be completed, the machinery will be installed and the structural steel superstructure started. Work on the south approach will be carried on simultaneously with that of the superstructure and both should be finished shortly.

SEWER SYSTEM.

Work on the main sewers during the past year was confined to the completion of the Mile Rock Tunnel and the Bakers Beach Outlet Sewer and the construction of sewers in South Bay View Districts, Oakdale Avenue, San Bruno Avenue to Selby Street and Sloat Boulevard, 24th to 31st Avenue, \$100,000 for the construction of the last three having been provided for in the last budget.

In the Islais Creek District a drainage channel was dug along the proposed route of a large reinforced concrete sewer, to reduce to a minimum the danger of floods from the winter rains, similar to those which have occurred in the past, until such time as local developments in the vicinity demand the construction of the main sewer.

MILE ROCK SEWER.

The last 30% of the Mile Rock Tunnel was completed, thereby providing an outlet for the storm waters of the western drainage area which includes the Ingleside, Sunset and Richmond Districts. This construction was done by the cut and cover method, as follows:—

The closing section, known as Section 1, was constructed in open cut located with center line $7\frac{1}{2}$ ft. west of center line of 48th Avenue and beginning at south property line of Cabrillo Street and extending north 536 ft. The flow in entire construction is from south to north on a uniform grade of .1605 to 100 ft. Inside dimensions of sewer section were $9' \times 11'$. Invert had a width of 11 ft. and difference from spring line of invert to flow line was 18 in. Side walls are 2 ft. high to spring line of arch and arch was constructed on uniform curve to radius of $5\frac{1}{2}$ ft. Side walls were 15 in. thick and reduced gradually to $9\frac{1}{2}$ in. at crown of arch. Invert had minimum thickness of 12 in. at flow line—subgrade being level transversely.

Section No. 1 was reinforced throughout with $\frac{1}{2}$ inch steel bars spaced at 6 inch centers.

The concrete mix was proportioned $1:2\frac{1}{2}:5\frac{1}{2}$. Niles River gravel was used entirely and sand removed from excavation fulfilled specifications.

The entire excavation of this section was in sand. Depth of excavation at north end of cut was 51 feet from crown of road and at the south end 34 ft. from crown of road. Natural water level at the time of construction was 10 ft. below road surface. Between surface and subgrade two sets of lagging were used, the upper set being 17 ft. in width, the lower set 14 ft. in width. All lagging was 3 in. x 8 in. pine, surfaced on two edges. For rangers 8 in. x 10 in. pine timber was used, and for spreaders 8 in. x 8 in. timber in first set and

8 x 10 used in second set. Spreaders were spaced at 10 foot centers and rangers on 4 foot centers. Considerable difficulty was encountered in preventing said underhead of water from boiling up in the bottom of excavation. This was overcome by driving second set of lagging about 4 ft. below subgrade and covering bottom of excavation to subgrade with gravel; plugging all joints in lagging with oakum in second set of lagging was necessary.

A 10 in. underdrain was used but proved to be too small to handle ground water which was carried to two sumps, one located at 48th Avenue and Balboa Street, the other at 48th Avenue and Cabrillo Street. At the 48th Avenue and Balboa Street sump one 3 in. and one 4 in. centrifugal pump were used; at 48th Avenue and Cabrillo Street sump one 6 in. and one 4 in. centrifugal pump were used. These pumped about 1,250,000 gallons of water per 24 hours, of which 407,000 gallons per day for 35 days were discharged into the completed sewer at Cabrillo Street and handled by City pumping station at 48th Avenue and Fulton Street.

All lagging, spreaders and bracers were removed by derrick and part of the excavation was handled by derrick. This derrick was of turntable type with 40 foot boom. This rig had an excavating capacity of approximately 200 yards per day near the surface but not better than 50 yards in deep cut.

The first 12 ft. of excavation was accomplished by a drag line excavator which removed a trench the entire width of the street and allowed lagging to be started 10 ft. below street grade.

The following tabulation shows the quantities for this section:—

Excavation by drag line	6,307 cu. yds.
Excavation by derrick	12,655 "
Concrete placed—invert	417.3 "
Concrete placed—sides and arch.....	660.0 "

Timber used to lag cut:

3 x 8 lagging	238.680 ft. B.M.
Rangers and spreaders.....	119.610 " "
Steel placed in section.....	31.1 tons

BAKERS BEACH SEWER.

June 30 of last year saw the contractor who had tried various methods of placing the 800 ft. of 18 in. cast iron flexible joint sewer pipe of the Bakers Beach Outfall Sewer, driving a pile trestle along the proposed line of the sewer, laying the pipe thereon, and lowering it as the laying progressed. This work has since been successfully completed at a total cost to the City of \$24,534.77.

PROPOSED SEWERS.

STANLEY STREET SEWER, to provide an outlet for the west side of the Ocean View District, will extend from the end of Stanley Street at the Spring Valley Water Company's property line northerly to join the existing sewer west of the Ingleside Terraces.

49TH AVENUE SEWER, from Lincoln way to Noriega Street, will drain into the 48th Avenue Sewer.

SEWER IN UNIVERSITY MOUND DISTRICT, will run in Somerset Street, Wayland to Felton Street and thence along Felton Street.

GLEN PARK SEWER, will connect at Burnside Street with the existing sewer and extend 500 ft. westerly therefrom.

STATEMENT OF 1904 SEWER BOND FUND.

EXPENDITURES.

Prior to July 1, 1915.....	\$1,852,404.96
From July 1, 1915, to July 1, 1916:	
Bakers Beach Outlet Sewer.....	\$18,740.54
Fulton St., 48th Ave to Great Highway.....	6,522.32
5th St., Howard to Brannan St.	67,872.95
Foerster St., Melrose to 33rd Ave.	2,469.32
48th Ave. and Fulton St., Sewage Pumping Station (Building)	2,010.31
48th Ave. and Fulton St., Sewage Pumping Station (Machinery)	531.03
Islais Creek, Mt. Vernon to Oneida (Sect. "N", North Point Main).....	30,180.64
	<hr/>
Total during last fiscal year.....	128,327.11
	<hr/>
Total to date.....	\$1,980,732.07
Amount available for new contracts.....	34,653.69
	<hr/>
Total receipts from sale of bonds and from miscellaneous sources	\$2,015,385.76

STATEMENT OF 1908 SEWER BOND FUND.

Prior to July 1, 1915.....	\$4,226,681.62
From July 1, 1915, to July 1, 1916:	
48th Ave. and Fulton St. Sewage Pumping Station (Building)	\$ 879.45
48th Ave. and Fulton St. Sewage Pumping Station (Machinery)	1,258.00
Mile Rock Tunnel Sewer.....	110,069.09
	<hr/>
Total during last fiscal year.....	112,206.54
	<hr/>
Total to date.....	\$4,338,888.16
Amount available for new contracts.....	1,234.97
	<hr/>
Total receipts from sale of bonds and from miscellaneous sources	\$4,340,123.13

AUXILIARY WATER SUPPLY SYSTEM FOR FIRE PROTECTION
1908 BOND.

Prior to July 1, 1915.....	\$5,737,014.92
Amount available for future contracts.....	15,959.47
	<hr/>
Total receipts from sale of bonds and miscellaneous sources.....	\$5,752,974.39

CONTRACT

Exclusive of Hetch Hetchy Water

Fisc

Contract	Contractor	Date Cont. was Awarded
Mile Rock Tunnel	Edward Malley	2-11-14
48th Ave. Sewage Pumping Sta., Building	Davis, Rogers Co.	6-3-14
" " " " Machinery	" " "	6-3-14
Bakers Beach Outlet	R. C. Storrie & Co.	7-24-14
5th St., Howard to Brannan St.	Healy-Tibbitts Co.	6-7-15
Fulton St., 48th Ave. and Great Highway and 46th Ave.	F. Rolandi	9-16-14
Islais Creek, Mt. Vernon to Oneida Ave.	F. Rolandi	9-13-15
Oakdale Avenue	Karl Ehrhart	5-31-16
Sloat Boulevard, 24th to 31st Ave.	Tibbitts-Pacific Const. Co.	6-9-16
South Bay View District	" " " "	12-20-15
El Portal Way	" " " "	8-25-15
Civic Center Sewer	Church & Clark	9-4-14
Stockton Street Tunnel	Jacobsen Bade Co.	4-11-13
Twin Peaks Tunnel	R. C. Storrie & Co.	11-2-14
Third Street Bridge—Furnishing Material and making Alterations	O. Monson	4-9-15
Third Street Bridge—Pile Bulkhead	Healy-Tibbitts Const. Co.	7-12-15
" " " Alteration of South Leaf	Thomson Bridge Co.	4-19-16
Fourth Street Bridge Construction	" " "	6-25-15
Twin Peaks Blvd., St. Germain Southerly	Eaton & Smith	6-25-15
San Bruno, Vista to Bay Shore	City Street Imp. Co.	6-11-15
" " Arleta to County Line	Fay Improvement Co.	6-25-15
Twin Peaks Blvd., Corbett Ave. to Sly boundary line of Twin Peaks Reservoir Site	F. R. Ritchie	9-20-15
El Camino Del Mar, through John Brickell Tract	John Brickell Co.	
" " " Lincoln Park to John Brickell Tract	City Street Imp. Co.	
El Camino Del Mar, John Brickell Tract to 200' Ely	" " " "	
Clarendon Ave. and Burnett Ave., Clayton St. to St. Germain Ave., Grading, Paving and Sewering	Flinn & Treacy	5-15-16
Corbett Ave., 24th St. to San Miguel Rancho	D. L. Bienfield	12-29-15
San Bruno Ave., Cortland to Steuben, Grading and Sewering	Federal Const. Co.	12-21-14
Oakdale Ave., between San Bruno and Railroad Aves., Grading	Church & Clark	4-30-15
Portola Drive, Stanford Heights to Junipero Serra Boulevard	R. G. Vaughn	2-26-15

EXPENDITURES.

Supply and Street Improvements.

Year 1915-16.

Date Cont. was Signed	Amount Expended		Total	Date Work was Accepted	Fund
	Prior to July 1, 1915	From July 1, 1915, to July 1, 1916			
CRS.					
2-28-14	\$ 108,548.38	\$ 110,069.09	\$ 218,617.47	6-9-16	1908 Sew.
6-30-14	(6,620.55	879.45	7,500.00)		1908 "
	(	2,010.31	2,010.31)	12-10-15	1904 "
6-17-14	(10,242.00	1,258.00	11,500.00)		1908 "
	(	531.03	531.03)	12-10-15	1904 "
8-13-14	7,041.33	18,740.54	25,781.87	11-12-15	1904 "
6-22-15	50.00	67,872.95	67,922.95	3-21-16	1904 "
9-29-14	16,661.85	6,522.32	23,184.17	7-14-15	1904 "
9-13-15		30,180.64	30,180.64	2-11-16	1904 "
6-13-16		2,415.09	2,415.09		General
6-20-16					"
1-3-16		28,144.43	28,144.43		"
9-2-15		9,701.10	9,701.10	11-24-15	Special
9-16-14	11,178.53	2,193.03	13,371.56	7-23-15	CH. and Civ. C. 1912
NELS.					
4-26-13	627,507.23	10,777.80	638,285.03	11-19-15	Spec. Assess.
11-2-14	1,145,471.76	1,131,132.56	2,276,604.32		"
OGES.					
4-28-15	4,982.30	7,357.49	12,339.79	9-22-15	General
7-28-15		1,932.00	1,932.00	8-27-15	"
4-29-16		2,487.00	2,487.00		"
7-8-15	5,779.30	45,499.45	51,278.75		"
WARDS.					
7-9-15		30,210.82	30,210.82	6-2-16	General
7-24-15		33,537.15	33,537.15		"
7-14-15		13,083.38	13,083.38	11-5-15	"
10-11-15		46,364.47	46,364.47		Good Roads
	13,673.50	29,326.50	43,000.00		Furn. by P. P. I. E.
		9,967.49	9,967.49		" " "
		2,589.04	2,589.04		" " "
6-7-16					G. R., P. Own's & A. W. S.
1-21-16		22,600.00	22,600.00		Good Roads
1-11-15	15,375.87	29,374.13	44,750.00	6-3-16	" "
5-8-15	12,097.50	12,595.31	24,692.81	3-24-16	General
3-18-15	30,195.98	18,384.15	48,530.13	7-9-15	"

CONTRACT EXPENDI

Exclusive of Hetch Hetchy Water

Fiscal

Contract	Contractor	Date Cont. was Awarded
MISCEL		
Sect. "A", Ocean Beach Esplanade	J. A. Hanuah	11-19-15
Hayes St., Steiner to Scott St.	F. Rolandi	8-4-15
Francisco St., Polk to Larkin St.	F. Rolandi	6-11-15
Municipal Water Works Extension	Tibbitts-Pacific Co.	3-24-16
Railroad Ave., Hollister to San Bruno	J. P. Holland	4-28-16
Cumberland St., Sanchez to Noe St.	F. R. Ritchie	6-21-16
Eighteenth and Indiana Sts. Crossing—Steel Stairway	Ralston Iron Works	5-15-16
15th St., Castro to Beaver St., Widening, Moving House at 176 Beaver St.	O. Monson	6-11-15
Islais Creek Channel Dredging Work	†J. P. Holland	2-7-16
Potrero Ave., 25th to San Bruno Ave., Paving	†Healy-Tibbitts Const. Co.	2-2-16
Relief Home Tract Boiler, No. 1	Eaton & Smith	6-21-16
" " " " No. 4	Scott Company	2-4-16
Central Fire Alarm Station No. 4	F. P. Walsh	2-4-16
Paris St., Italy to Amazon, Grading	General Electric Co.	10-2-14
	Eaton & Smith	11-15-15
RAIL		
Work Car Body, No. 29A	Pacific Car & Equip. Co.	7-30-15
*Work Car, Air Brake Equipment, No. 29C		
Work Car, Trucks, No. 29D	J. G. Brill Co.	7-30-15
Work Car, Motor Equipment, No. 29B	Westinghouse Co.	7-30-15
Track Special Work, Church St.	U. S. Steel Products Co.	7-26-15
Ties, Redwood, Church Street Railway	Navarro Lumber Co.	8-20-15
Sand Bins in Car Barns, Steel	Ocean Shore Iron Works	11-26-15
Machine Shop Equipment at Pipe Yard	(Various)	
Lockers, Car Barn, 17th St. and Geary St.	Ralston Iron Works	5-12-15
Division St., Bryant to 10th St., Rearrangement of Fire Department Stables	F. Rolandi	7-12-15
Church St. Rwy. Const., 16th-18th and 22nd-30th Car Bodies	Western Motor Draying Co.	1-19-16
Rails, Joints, Fastenings, Spikes, Sect. A and D	Jewett Car Company	1-2-14
Electrical Conductors, Church Street	U. S. Steel Products Co.	7-28-15
Copper Rail Bonds, Furnishing and Installing	E. Earle Browne	2-11-16
Concrete Trolley Poles for Church St. from 16th to 18th and 22nd to 30th Sts.	Bell & Jamison	3-20-14
Church St. Rwy. Const., 18th to 22nd St.	John Spargo	1-19-16
Auto Truck and Tower for Trolley Repairs	Contra Costa Const. Co.	12-10-15
Mariposa, York to Hampshire	Kelly-Springfield M. T. Co.	11-26-15
Tank and Tower, Geary Street Car Barn	City Street Imp. Co.	3-15-16
Tank and Tower Foundations, Geary St. Car Barn	Pacific Tank & Pipe Co.	4-2-13
2nd Story Geary Street Car Barn	Eaton & Smith	6-11-15
	Jas. L. McLaughlin	7-30-15

† Informally awarded.

* Materials ordered on requisition.

TURES—Continued.

Supply and Street Improvements.

Year 1915-16.

Date Cont. was Signed	Amount Prior to July 1, 1915	Expended From July 1, 1915, to July 1, 1916	Total	Date Work was Accepted	Fund
LANEWAYS.					
12-6-15		25,348.45	25,348.45		General
8-31-15		24,120.00	24,120.00	6-4-16	"
		7,489.04	7,489.04		Spec. Ass.
4-7-16		1,831.13	1,831.13		General
5-24-16		1,027.55	1,027.55		"
7-7-16		497.50	497.50		"
6-14-16					"
6-25-15		1,760.00	1,760.00	9-30-15	"
		882.50	882.50		"
2-23-16		4,116.37	4,116.37		"
7-12-16					"
7-25-16					
2-28-16		1,101.80	1,101.80		"
10-29-14		887.00	887.00	11-19-15	"
12-1-15		3,709.68	3,709.68	3-15-16	"
ROADS.					
8-14-15)				2-9-16	1913 Rwy. Bonds
)					
8-19-15)		6,706.64	6,706.64	12-1-15	" " "
8-25-15)				12-24-15	" " "
12-15-15		4,264.00	4,264.00	3-8-16	" " "
11-20-15		4,889.60	4,889.60	2-18-60	" " "
12-6-15		1,760.00	1,760.00	1-26-16	" " "
	6,194.52	1,325.39	7,519.91		" " "
5-27-15		2,820.00	2,820.00	8-16-15	" " "
		8,738.54	8,738.54	1-5-16	" " "
2-3-16		56,734.03	56,734.03	6-2-16	" " "
1-16-14	344,161.50	21,750.00	365,911.50	10-22-15	" " "
12-1-15		38,323.67	38,323.67	2-23-16	" " "
2-25-16		5,353.31	5,353.31		" " "
4-2-14	29,693.65	2,975.10	32,668.75		" " "
2-3-16		6,404.41	6,404.41		" " "
12-27-15		93,371.79	93,371.79		" " "
12-13-15		2,165.00	2,165.00	6-28-16	" " "
3-28-16		1,100.00	1,100.00	5-10-16	Mun. Rwy.
4-14-13		1,462.00	1,462.00	2-9-16	1910 Rwy. Bonds
7-6-15		595.00	595.00	9-3-15	" " "
8-14-15		26,247.00	26,247.00	5-26-16	" " "
\$2,395,495.75		\$2,087,493.22	\$4,482,968.97		

HETCH HETCHY WATER SUPPLY.

WATER RIGHTS AND PROTECTIVE WORK.

According to the provisions of San Francisco's Hetch Hetchy grant, the development of the City's Sierra water supply "shall be prosecuted diligently and no cessation of such construction shall continue for a period of three consecutive years, and in the event that the Secretary of the Interior shall find and determine that there has not been diligent prosecution of the work or of some integral and essential part thereof, or that there has been a cessation of such construction for a period of three consecutive years, then he may declare forfeited all rights of the grantee herein as to that part of the works not constructed, and request the Attorney General, on behalf of the United States, to commence suit in the United States District Court for the Northern District of California for the purpose of procuring a judgment declaring all such rights to that part of the works not constructed to be forfeited to the United States".

Pursuant to a policy of active development, construction was started simultaneously at several locations in 1915, the extent of activity at each point being determined by the funds available from a restricted sale of 4½% bonds due to market conditions, and by the relative value of each unit in furthering the City's plans.

At the Early Intake, twelve miles below Hetch Hetchy dam site, water released from that reservoir site, and flowing along the natural bed of the river channel, will be diverted into pressure tunnel 10½ ft. in diameter, which for some years to come will be the easterly terminal of the City's main aqueduct. This tunnel will pass beneath the mountain backbone on the south side of the Tuolumne River for a distance of 19 miles, to the Priest's Hill regulating reservoir near Moccasin Creek. The vicinity of the upstream intake portal has been excavated and the tunnel face started ready for power drills. The excavation of a bench in the slope above the river floods for the aqueduct leading from the early intake diversion damsite to the tunnel portal is also under construction, and in this portion of the aqueduct will be placed necessary sand screens and scouring chambers to automatically intercept any floating sand or debris, thereby preventing clogging of the aqueduct and dependent reservoirs.

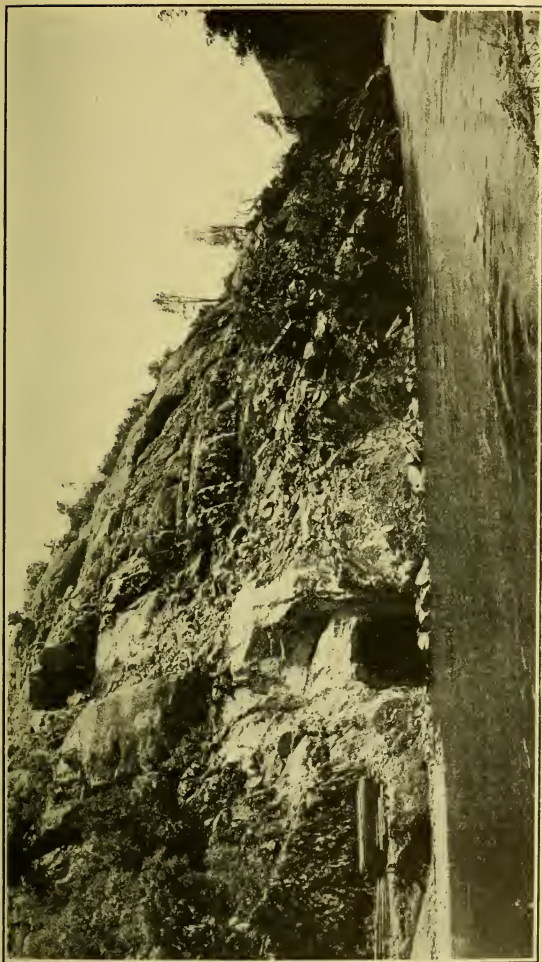
A suspension foot bridge was built across the river at Early Intake to allow the men working on the tunnel to cross over to the construction camp, which will be built on the northerly bank of the river where advantage can be taken of whatever sunshine is available in this deep canyon, for sanitary reasons.

Work on the Early Intake Road, begun in 1914, was continuously prosecuted with a small force until the very heavy snowfall necessitated its discontinuance in December, 1915. This road is now approximately 80% completed. The work has been resumed for this year. The Early Intake wagon road was completed down to the camp on the Tuolumne River. Some few slides were removed from the road.

Work has been continued on the bench for the aqueduct from Early Intake diversion dam to Early Intake tunnel portal. A large portion of this bench is completed and the tunnel portal is faced, ready for regular tunnel work.

The nine mile road from Hog Ranch to Hetch Hetchy damsite, constructed by the Utah Construction Company, under Contract No. 1, was surfaced in the spring of 1915, so as to put it in condition for the heavy wagon loads which were hauled for the installation of the sawmill, compressor, and other work.

Following the surveys of 1914, the application map for which was approved by the Secretary of the Interior on January 21, 1915, a road was constructed from Hetch Hetchy camp down into the floor of Hetch Hetchy Valley. This road has a length of .85 mile and was built on a 10% grade. It allows of access to Hetch Hetchy Valley by team or auto truck, which has been considered



Portal of Diversion Tunnel at Hetch Hetchy Dam site.

necessary as a construction adjunct to the main dam. The road was constructed entirely by day labor by City employes.

Trails were built from Hetch Hetchy camp down to and around the dam site and a road was built to allow of the hauling and installation of all plant, to be used in construction of not only the diversion tunnel, but also the diversion and main dams.

A trail was begun from the main road between Colfax Gate and the Toll Bridge, leading toward the proposed aqueduct crossing on South Fork. This trail has not yet been completed.

In conjunction with the Forest Service and other interested parties, a bridge was built over the Middle Fork on the road between Hog Ranch and Sequoia. Before this bridge was built, the road was impassable when the Middle Fork was at high stages, and it was then necessary to ford the river.

PERMANENT CAMP.

Following the topographic survey of the Hetch Hetchy camp, studies and designs were made in the office for the main camp for housing the men to be engaged on the construction of the Hetch Hetchy dam.

The construction of camp buildings at the Hetch Hetchy dam site was begun in September, 1915, the first building constructed being the dining room, 120 ft. by 40 ft. This was followed by building of bunk houses and cement warehouse. There have been built also several 3-room cottages, a hospital, wood house, oil house, meat house, and other buildings. A water system with wooden tanks and 2-inch water mains has been completed, and roads around the camp have been undertaken.

DIVERSION TUNNEL.

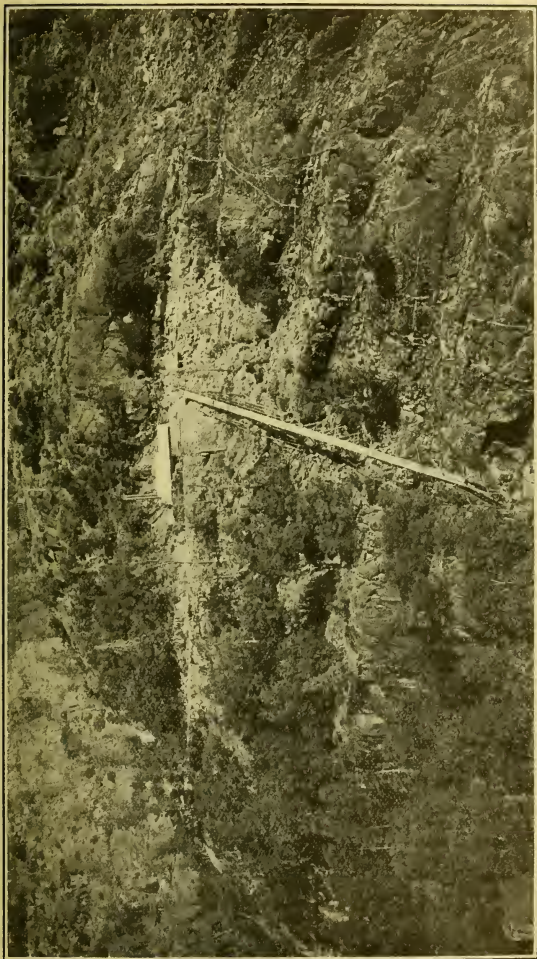
For the purpose of by-passing the stream flow of the Tuolumne River during the excavation of the foundations for the dam and the construction of the dam proper, a tunnel was drifted at the dam site. This tunnel was commenced late in September, 1915. Owing to the difficulty of securing prompt delivery of the compressor plant, due to tardiness in plan approval by Interior Department officials, the work was begun by hand drilling. When the tunnel heading was well started, two crews were put on, working night and day, and the heading was drifted through on the 30th day of December.

The main tunnel is to be 20 ft. in diameter. The completed heading is approximately the upper half of the whole tunnel. The excavation of the bench on the remaining half is now being carried on. The rock is a very hard grade of granite requiring no timbering and is a good indication of the nature of the excellent foundation of the main Hetch Hetchy dam. A portion of the spoil has been saved for use in the concrete construction of the diversion dam.

DIVERSION DAM.

Preparations have been made to construct the diversion dam to divert the river flow into the diversion tunnel, above mentioned, for unwatering the main dam site. A bench was made for hoisting engine, the engine installed, and derrick parts and cable hauled in and put in place preparatory to storing sand from the river bed. Lumber for flume and form construction has been delivered on the ground from Canyon Ranch sawmill.

The commencement of both the diversion tunnel and diversion dam was delayed from April till August—four months—due to lack of approval of plan program by the Assistant Secretary of the Interior. It is needless to state that delays of this nature prove a hardship and serious handicap to the City, where the fair weather season is so short, due to winter snows, etc. Work on the diversion dam is progressing favorably, and should be completed by next December.



South Abutment of Hetch Hetchy Dam, Showing Compressor Plant and Skiway.

TELEPHONE LINE.

The City's telephone line from Groveland to Hog Ranch was extended as a single iron wire from Hog Ranch to Hetch Hetchy camp. Some repairs and improvements in the old line were also made. The line is now in operation from Groveland to Hetch Hetchy dam site. A branch line has been built to Early Intake and is now in operation.

CANYON RANCH SAWMILL.

A site for the sawmill at Canyon Ranch in the City's property owned in fee was selected in the spring, and in April, 1915, grading was begun thereon. This was followed by felling and hewing of timbers sufficient to construct the first part of the frame for the mill. The final timber work was made with timber sawed at the mill.

Sawmill machinery, purchased under Contract No. 2, was delivered at Chinese and hauled to Canyon Ranch during June. The machinery was completely installed early in July and sawing was begun on July 21, 1915.

Great care was observed to preserve the natural forest appearance of Canyon ranch, and not mar the scenic features of the National Park by the City's activities. One of the means used was to leave untouched a screen of trees immediately next to the railroad.

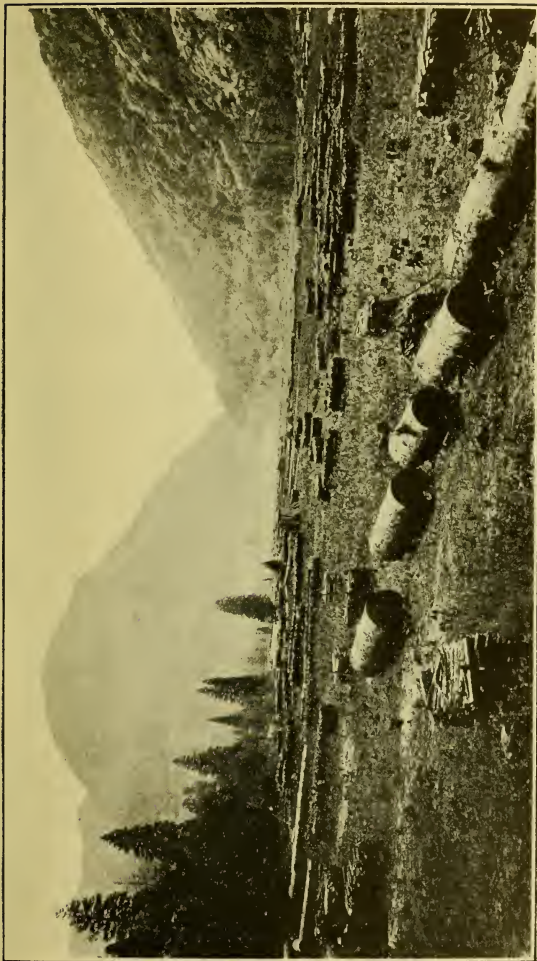
Sawing was continued until November, when, on account of the snowfall, the mill was shut down. About 1,200,000 feet B.M. were manufactured during the season, a portion of this being surfaced. A large portion of this lumber was hauled to Hetch Hetchy dam site for use in permanent camps, a portion was used at the sawmill in construction of frame for the mill, office, bunk houses, etc., and the remainder was piled for seasoning. The area on which the timber was cut at Canyon Ranch has been cleared, the slash and brush burnt in a satisfactory manner. During December the mill was housed in, engines, etc., covered, and everything put in good style to withstand the winter storms.

There is now remaining on Canyon Ranch about 800,000 ft. B.M. of timber, which can be cut by the mill. In the floor of Hetch Hetchy Valley there are about 2,000,000 ft. B.M. of logs suitable for saw timber.

Work at the sawmill was resumed in April, 1916, and is progressing satisfactorily. An average day's run yields about 15,000 board feet sawed and surfaced.

DEFENSE AGAINST OPPOSITION WATER AND POWER CONCERNS.

The Yosemite Power Company has pending before the Department of the Interior applications for rights on the Tuolumne River in the National Park and Forest Reserve, which conflict seriously with the development works as proposed by the City. A determined stand was made by this office against the United States Government approving the validity of these claims, hydrographic and other data was prepared and submitted to United States Government officials and studies made by the company's proposed hydro-electric power development. The City Engineer with the City Attorney and the Clerk of the Board of Supervisors left for Washington, D. C., on January 18, 1916, to oppose the claims of this company, which is controlled by the Hammond interests. The hearing of both sides was held before the Secretary of the Interior on January 26, 27 and 28, and the objections presented by City officials taken under advisement by him. Little doubt is felt of a verdict favorable to the City, for in a similar proceeding in 1912, Ex-Secretary of Agriculture Wilson ejected the National Park Electric Company, another wildcat concern, from the National Forest, at the request of the City, under conditions which were practically identical with those obtaining in the present case.



Clearing Bottom of Hetch Hetchy Reservoir.

LOWER CHERRY POWER DEVELOPMENT.

In order to supply power for construction purposes at Hetch Hetchy dam site and along the tunnel aqueduct line, work is in active progress on a temporary power plant to be located near Early Intake. An aqueduct line 17,000 ft. in length, including 4,400 ft. of tunnel, 5,200 ft. of flume and 7,400 feet of open ditch will be constructed during the present year, bringing water from Cherry Creek to the forebay 300 ft. above the power house at Early Intake.

During the latter part of April, surveys were commenced for the diversion dam, which will direct the waters of Lower Cherry Creek into this aqueduct, and also for the aqueduct line and power house location. The line of this aqueduct has been cleared, a trail built the whole length of its development and camp buildings erected for the use of men engaged on the construction work.

There will be five tunnels on the aqueduct line, 7 ft. 6 in. wide and 7 ft. 6 in. high, with arched roof. These will be awarded by contract, which will call for completion within a period of 150 days. The open ditch work and flumes will be built by day labor.

The Early Intake wagon road is being extended from its present terminus, near the permanent aqueduct bench, across the river by a bridge and thence up a 10% grade to the Cherry Aqueduct line. At the present time the bridge is being constructed.

In addition to the road work necessary for the Cherry power development, considerable repair work has been necessary on the roads from Groveland to the Early Intake on which a surfacing crew has been almost continuously engaged.

For the equipment of the Lower Cherry power plant, contracts will be awarded immediately in order that deliveries may be secured in ample time to install the generating machinery early next spring.

A temporary storage dam will be constructed near the outlet of Lake Eleanor, in order to raise the level of the lake and make available, for power purposes, an additional water supply.

It will be necessary to have a continuous flow of 120 second feet in the Lower Cherry power canal for a continuous generation of 2400 K.W. The ordinary flow of the stream for the four driest months of the year does not supply this amount.

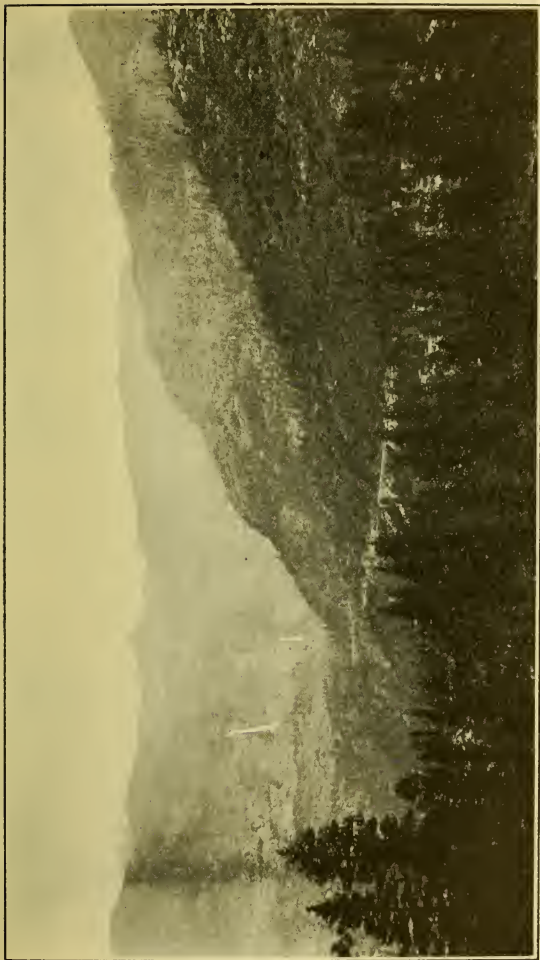
Whether the temporary dam at Lake Eleanor will be an earth fill or a timber crib structure, has not been decided, but which ever type is adopted as most suitable and economical will be finished before the spring of 1917, in order to make available next year the rainfall and waters from the melting snows of the coming winter.

CONTRACTS.

The following contracts were operative during the past year:

Contract No. 1. For constructing road from Hog Ranch to Hetch Hetchy Dam. This work was begun in August, 1914, and completed in February, 1915, by the Utah Construction Company, at a total contract price of approximately \$180,000. 9.09 miles of 22-foot roadbed was graded. The maximum grade is 4% and the minimum radius of curvature 191 ft. The greater part of the material handled in grading was solid granite. The roadbed was later surfaced, as elsewhere noted in this report, and is now being utilized for the transportation of machinery, materials and men to and from Hetch Hetchy Valley. It will form a part of the roadbed for the railroad now being constructed under Contract No. 7. Previous to the construction of this road, the Hetch Hetchy Valley was accessible only by trail.

Contract No. 2. For furnishing Sawmill Machinery. Bids were received on April 14, 1915, and the contract was awarded on April 19, to the Eby Machinery



Recently Constructed Railroad Grade into Hetch Hetchy Valley.

Company, for the sum of \$4,975. Final payment was recommended on August 31, after a successful trial run of the machinery.

Contract No. 3. For Furnishing Logging Engine. Bids were received on April 14, 1915, and the contract was awarded on April 28, to the Western Equipment Company for \$2,950. Final payment was recommended on August 19, after a successful trial run of the logging engine.

Contract No. 4. For Clearing Portion of Hetch Hetchy Reservoir Site. Bids were received on September 15, 1915, but were rejected (September 20) on account of irregularity in the lowest bid. The contract was re-advertised, bids being received on September 29, and award was made to A. J. Reeder on October 1, for the estimated sum of \$31,675, with a possible bonus of \$1,500. A large amount of cord wood and of saw logs cleared from the reservoir and usable as fuel and construction timber, has been saved for the City's use. Already the amount of cord wood provided for in the contract has been cut.

Contract No. 5. For Furnishing Air Compressing Plant and Drills. Proposals were received on September 8, 1915, and the contract awarded on September 15, as follows:

Proposition No. 1.—Boilers, to the Chicago Pneumatic Tool Company, for \$2,877.

Proposition No. 2.—Air Compressor, to Ingersoll-Rand Company of California, for \$3,019.

Proposition Nos. 3, 4 and 5—For Drills, Receivers, Sharpener and Accessories, to Rix Compressed Air Drill Company, for \$4,431.50.

This machinery was delivered to Hetch Hetchy dam site in November. It has all been assembled and is ready for regular operation.

Contract No. 6. For Furnishing Hoisting Engine and Boiler. Proposals were received on October 8, 1915, and contract awarded on October 11, to A. L. Young Machinery Company for \$1,357. The engine was delivered at Hetch Hetchy dam site in November and installed, as noted under "Diversion Dam".

Contract No. 7. For the Construction of the Hetch Hetchy Railroad. Specifications were prepared for this work and proposals received on October 28, 1915. The proposals were six in number, the lowest being that of F. Rolandi of this City, for the estimated sum of \$1,543,080.74. This bid was accepted by the Board of Public Works on December 6, 1915.

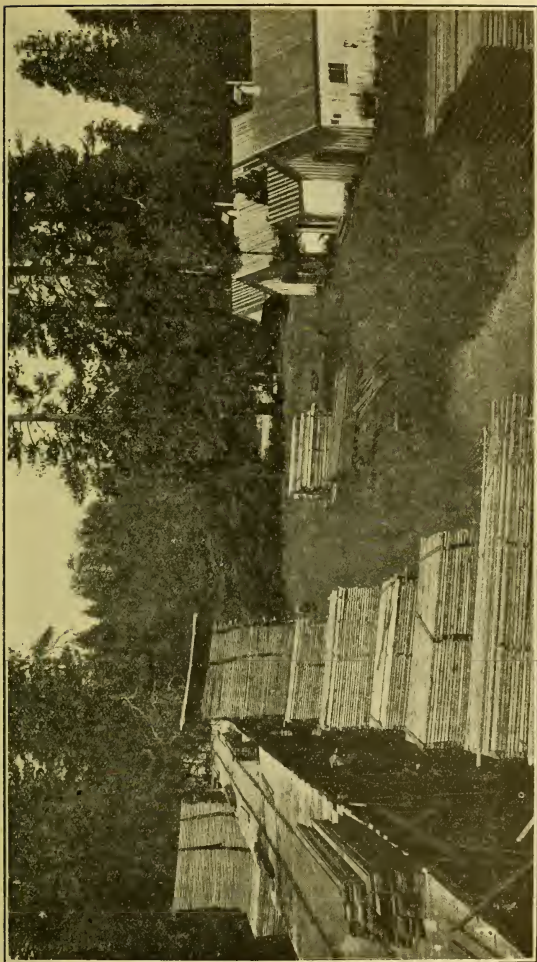
This contract will include grading 58 miles of line, from Hog Ranch to Rosasco, furnishing all materials and constructing a railroad over the total 67.63 miles, with necessary sidings and other accessories, from Rosasco to Hetch Hetchy dam site.

Work has been continued with a maximum force of 500 men. At the present time there are slightly over 400 employed by the Contractor.

The estimated value of the work completed June 30, was \$318,346. The Contractor now has one steam shovel on the ground and expects to operate two more.

The grading is approximately 40% done; construction of concrete piers for the Tuolumne River Steel Bridge has been begun and a large amount of construction material, such as rails, ties, switches, and lumber for trestles, has been delivered at Rosasco.

Contract No. 8. For Furnishing Cement. Bids were received October 23, 1915, and contract awarded on October 26, to the Santa Cruz Portland Cement Company, for furnishing at Chinese Station 3,975 barrels of cement. The contract price was \$10,613.25. Delivery was begun immediately upon award of contract, but the early rainfall and snow interfered with the hauling to such an extent that the completion of delivery had to be deferred until the end of winter. At the present time there have been delivered at Chinese Station 3400 barrels and the contract is practically complete. This cement is to be used in the construction of the diversion dam, the preliminary work for which has already been done.



Timber Cut at City's Sawmill, Five Miles from Hetch Hetchy Dam site.

Contract No. 9. For Hauling Cement from Chinese, a Station on the Sierra Railway of California, Tuolumne County, to Hetch Hetchy Dam Site. Bids were received on November 5, 1915, and contract awarded on November 6, to Charles B. Dunham at \$23 per ton. Hauling was begun immediately upon award of contract and carried on intermittently, as rapidly as the weather and conditions of roads would permit. The contract has been practically completed.

Contract No. 10. For Drifting Tunnels, Lower Cherry Aqueduct. Specifications have been prepared and contract will be awarded in the near future.

Contract No. 11. For Making Core Borings, Hetch Hetchy Aqueduct. Specifications for this contract were transmitted to the Board of Public Works on June 30, and proposals received on August 9, 1916.

The work will consist of securing for examination about 8,000 ft. of 15/16 in. core from holes to be bored along the line of the Hetch Hetchy Aqueduct, between Early Intake and Priest Regulating Reservoir. The data thus secured will be indispensable for obtaining a knowledge of the material that will be traversed by the aqueduct tunnels.

Contracts No. 12 and 13. Specifications for these contracts for hydraulic and electrical machinery at Cherry Power Plant have been prepared, and provide for the delivery of hydro-electric machinery early in 1917, in order that the program of the City Engineer for the construction of the Hetch Hetchy System may be carried out as outlined in this report of March 25, 1916, to his Honor the Mayor, the Board of Public Works and the Board of Supervisors.

STREAM MEASUREMENTS.

Hydrographic and meteorologic observations have been continued, as previously noted. The City Engineer is endeavoring to reduce the number of employees of the U. S. Geological Survey paid for by the City to perform this work.

SURVEYS.

During the construction of the Hetch Hetchy Railroad it has been necessary to maintain five parties of surveyors for the purpose of general staking and supervision of grading work, installation of culverts, cross section work and estimates for payments to Contractor. Several slight revisions of the alignment have been made, which will reduce the total construction cost and result in better alignment.

Upon the completion of the location survey of the Hetch Hetchy tunnel aqueduct from that point to the westerly boundary of the Stanislaus National Forest. The relocation of this line was determined after extensive cost analyses, as well as geological studies.

The new aqueduct line crosses the South Fork of Tuolumne River at a point near the confluence of the Middle Fork, the crossing being a very low bridge. With the old aqueduct location, an expensive inverted siphon would be necessary, in which water would be under very high pressure. This undesirable feature is eliminated in the revised location, which places this 19 mile section of the aqueduct on a uniform gradient.

A preliminary line has been run from Priest Reservoir to the Moccasin Creek Power house site, and thence a location survey has been run to Red Mountain Bar. At this point the aqueduct will cross the Tuolumne River on a structure, the nature of which has not yet been definitely determined. For purposes of study, a detail topographic survey was made of the site of the proposed crossing. The survey has been continued from here to the westerly boundary of Tuolumne County, which will be approximately the end of the tunnel aqueduct and the head of San Joaquin Valley pipe line.

The location of the Hetch Hetchy Aqueduct from Oakdale westerly across the San Joaquin Valley has been partially completed. At the end of June this work had been carried about 36 miles, or close to the right bank of the San Joaquin River. This survey will be completed to Irvington Gate House before the winter, and maps thereof filed with the Secretary of the Interior, in accordance with the provisions of the Raker Bill.

Preliminary to the clearing of the floor of Hetch Hetchy Valley, to the elevation which was to be flooded by the construction of the diversion dam, an average depth of about 30 ft., a survey was made of the 3,560 foot contour, which was flagged out on the ground for the guidance of the men engaged in clearing the reservoir site.

The Hetch Hetchy dam site was accurately resurveyed and topographic map made thereof. This map was the basis of final studies of type of dam to be constructed, and also of location of this and various appurtenant structures.

For the purpose of making descriptions of the rights of way, along the Hetch Hetchy Railroad, resurveys were made of the townsites of Big Oak Flat and Groveland. The original surveys of these townsites were very roughly done in the mining days of 60 years ago, and without the resurveys it was impossible to determine with any accuracy the location of the property lines. This work has now been completed and the rights of way are being definitely established as a result of it.

The Indian lands in the Big Creek Valley, near Groveland, were surveyed, as well as a number of mining claims along Moccasin Creek, as the railroad traverses these lands and the descriptions were needed for right of way purposes.

GEOLOGY.

In connection with the location of the Hetch Hetchy aqueduct tunnels through the Coast Range Mountains, from Tesla to Irvington, it has been necessary to make a thorough geological survey of this district. The field work in connection with this survey was practically complete by the end of June.

The determination of the best location for the Tuolumne portal included a study of the location of the San Joaquin River crossing of the Hetch Hetchy aqueduct pipe line, and the question was considered as to whether it would be advisable to change the river crossing from the location tentatively recommended previously, but a careful analysis resulted in retaining the location as originally suggested.

ALAMEDA CREEK HYDROGRAPHY.

The work of gauging the water sources of the Spring Valley Water Company, in Alameda County, begun in 1914, has been continued during the past fiscal year. The accumulation of accurate data and determination of the reliable yield of these sources is of great importance to the City in connection with not only any future purchase of the Spring Valley Water Company, but for any controversy in which the Company and the City may be involved.

APPLICATIONS TO DEPARTMENT OF INTERIOR.

Amended application for Lake Eleanor Reservoir and application for Cherry-Hetch Hetchy Tunnel Aqueduct in Stanislaus National Forest were filed March 9, and approved, respectively, December 27 and December 24.

Applications for the following rights of way were also made:—

Hetch Hetchy Railroad, from Hog Ranch to west boundary of Forest, filed May 28, approved October 12;

Hetch Hetchy Railroad, from west boundary of Forest to Priest Reservoir, filed June 11, approved October 15;

Hetch Hetchy Railroad, from Priest Reservoir to Red Mountain Bar, filed August 18, approved October 12;

Hetch Hetchy Railroad, from Red Mountain Bar to Rosasco, filed November 1, approval still pending.

Application map for Lower Cherry Aqueduct, Dam Site and Power House Site, filed in April was approved on June 22.

Map of Priest Regulating Reservoir, Dam Site and portion of watershed, necessary for protection of reservoir against pollution, filed in April was approved June 22.

Map of amended location of Hetch Hetchy Tunnel Aqueduct, from Early Intake to the west boundary of Stanislaus National Forest, was prepared and on June 30 was ready for filing. This last application is of the new aqueduct line, as noted on pages 28 and 30 of the report of March, 1916.

Application map of Hetch Hetchy Railroad, from Red Mountain Bar to Rosasco, filed November 1, 1915, was approved December 27, 1915.

CITY DISTRIBUTING SYSTEM.

Pending the settlement of the suit instituted by the Spring Valley Water Company for the adjustment of water rates in San Francisco, realizing that the outlying districts were in urgent need of immediately supply, on the recommendation of this office, the Board of Public Works was authorized by Resolution No. 10,869 of the Board of Supervisors, to sink test holes on property belonging to the City and County in Richmond and Sunset Districts, to determine the feasibility of obtaining a supply from wells in this locality.

Ten test holes were bored and proved the water-bearing possibilities of this district. Contracts were therefore entered into for five wells, the total cost of drilling which amounted to \$13,895.94. The cost of the ten test holes amounted to \$4,250.25. It is estimated that from the wells already drilled a permanent supply of 1,000,000 gallons a day can be secured. Therefore, if it ever becomes necessary to supply portions of the Richmond or Sunset Districts from this source, the necessary pumping station can be installed and distributing reservoir constructed.

Subsequent to the drilling of the wells, however, on July 3, 1915, the following Resolution was passed by the Board of Supervisors (No. 11,886, New Series):

"Whereas the Spring Valley Water Company has submitted in writing an offer to make certain needed extensions to its water mains in the City and County of San Francisco; and

"Whereas, One of the conditions of said offer is that the cost of installing said mains shall be added to price which may be fixed upon the properties of said Company now under condemnation in suit No. 53708 in the Superior Court of this City and County; now, therefore, be it

"Resolved, That the City Attorney is hereby authorized and directed to enter into a stipulation in said case with the Spring Valley Water Company to the effect that the cost of such extensions when completed may be added to the value of the properties found by the Court as of the day on which the summons was issued".

Pursuant to this agreement, the Spring Valley Water Company has installed since July 3, 1915, the following pipes in the various districts:—

RICHMOND DISTRICT.

16"	main	in 23rd Ave., from Fulton to Geary Sts.
12"	"	" Anza St., 23rd to 29th Aves.
12"	"	" 29th Ave., from Anza to Balboa Sts.
12"	"	" Balboa St., from 29th to 31st Aves.
8"	"	" Balboa St., from 31st to 42nd Aves.
8"	"	" 42nd Ave. from Balboa to Geary Sts.
8"	"	" Fulton St., from 10th to 23rd Aves.
8"	"	" 28th Ave., from Anza to Geary Sts.
8"	"	" 21st Ave., from Anza to Geary Sts.
6"	"	" 18th Ave., from Fulton to Cabrillo Sts.

GARBAGE DISPOSAL.

A number of propositions for the disposal and destruction of refuse and garbage have been submitted to the City authorities during the past year and have been referred to the City Engineer for consideration and report. The several propositions are herein briefly summarized and commented on with a view of showing the apparent merits or objections that may be advanced regarding the operation and the results that may be had therefrom, of the different projects submitted.

Collins & Pellett, under date of December 17, 1914, proposed to install four garbage crematory incinerators to have a total guaranteed capacity of 512 tons a day, for a price of \$340,000, the sites for the incinerators to be furnished by the City. Collins & Pellett will guarantee these plants to be odorless and practically smokeless.

They also make an alternate offer for the City to give them a contract franchise for 15 years and grant them full control of garbage collection and at the end of the 15 years' period they agree to turn over the plant to the City without cost. In this proposition also the City shall furnish the sites for incinerators. The plants will be housed in fireproof buildings which shall be supplied by the Contractors.

By "control of collection" above mentioned, Mr. Collins states that they mean they shall take over and operate the entire collection of waste, garbage, ashes, swill, etc., now collected by the scavengers and the two or more reduction companies that are operating in the City. This will make it necessary for the Supervisors to pass such ordinances as may be required to give complete control of the whole collection situation to Collins & Pellett. They do not go quite so far as to suggest the entire confiscation of the scavenger business, but say they will make adequate and satisfactory arrangements with the scavengers, even to the extent of buying out their horses and wagons and then engaging the drivers and collectors by the day. They would also undertake to control the collection of swill and other waste now handled by the Reduction Companies in South San Francisco, and the reduction companies would then be compelled to arrange with Collins & Pellett for the products these companies now collect for themselves.

Collins & Pellett also, under date of July 22, 1915, made three propositions to the City as follows:—

Proposition No. 1: To construct an incinerating plant of the type of Nye's Improved or Lea's Garbage Crematory Incinerators, on site to be furnished by the City, with a capacity of 512 tons per 24 hours, at a cost of \$340,000. This plant is guaranteed to be without any offensive odors or gases and practically smokeless in operation.

Proposition No. 2: To construct on site furnished by the City a Nye's Improved or Lea's Garbage Crematory Incinerator to dispose of the entire output

of the City's garbage and waste, for a period of 15 years, and at the expiration of that period to turn over the entire system to the City free and clear of incumbrance and in good running order, without further cost to the City; provided Collins & Pellett are given "control of the entire system of collection and disposal of garbage for said period of 15 years".

Proposition No. 3: To erect on sites furnished by the City, Nye's Improved or Lea's Garbage Crematory Incinerator and to operate these incinerators free of cost to the City and to pay to the City \$90 per day for every working day of the year; provided Collins & Pellett are given "full control of collection and disposal of the entire output of the City's garbage and waste", and at the expiration of 25 years to deliver the plants to the City at appraised valuations, Or, should the City extend the franchise to a period of 35 years, Collins & Pellett will undertake to deliver all the incinerating plants clear of incumbrance and without cost to the city.

Attention has already been called to the proposed "control of collection" that Collins & Pellett are asking for and this is a provision that would be very difficult to carry out with satisfaction to most of the people concerned excepting perhaps Messrs. Collins & Pellett. Attention is also called to their guarantee that there shall be no "offensive odors or gases" and that the plant shall be "practically smokeless in operation".

There is an incinerating plant of the Nye's and Lea's improved type now in operation in the Presidio Military Reservation in San Francisco, for the destruction of refuse and garbage from the hospital and waste from officers' quarters in the Presidio. This incinerator is a destructor of the flat hearth type enclosed in a corrugated iron building and is said to have cost about \$4,000 when built. It consists of a burning hearth upon which the refuse to be burned is delivered through a chute at the rear and distributed by poker in the hands of attendant. The destructive fire is supplied by an oil burner, which fire is projected into the furnace and deflected across the hearth by an angle wall at the rear end. The refuse, before being fed into the furnace, is dumped upon a platform on a level with the roadway and when the ash pan below the burning hearth is full of ashes and other burned material the grate is rolled out on rails provided for same and the ash removed by hand to the dump.

The rated capacity of the unit is about 16 tons of refuse or garbage daily. The capacity of this type of furnace seems not to have been tried out and there does not appear to be any installed where continuous operation is required. Mr. Collins states there are several of the plants in some of the Southern States and all operating with satisfaction.

The furnace seems to be of the type and construction suitable for burning small quantities of refuse in small towns, as the resulting odors and smoke are not in such volume as to form much serious objection. Should there be assembled in one plant a sufficient number of these furnaces to burn 500 to 600 tons a day, or, as suggested by Mr. Collins, to install four plants in different parts of the City, each of which would have a capacity of about 150 tons a day, it is not possible to estimate what degree of nuisance might result from the combined odors and smoke from all the furnaces of the group.

Regarding fuel expense the records would indicate that the plant at the Presidio requires something between 24 cents and 35 cents worth of fuel oil per ton of refuse. It is probable that with larger installations and more continuous operation the amount of fuel oil required per ton of refuse would be less than in such a small plant as the one at the Presidio.

Neil H. McKay, Civil and Sanitary Engineer, San Francisco, under date of December 1, 1915, made a proposition as follows:—

To design, erect, and test, to the satisfaction of the City and County of San Francisco, one Sparks Garbage Incinerator, of one unit, with a rated capacity

of 8 tons per day as a demonstration plant, on a plot of ground to be furnished by the City, under the following guarantee:—

1. To destroy 8 tons of garbage and refuse a day.
2. The plant will be odorless and inoffensive.
3. The plant will be constructed in a thoroughly mechanical and workman-like manner.
4. Residue will be free from organic matter.
5. No restrictions on any grade or classes of garbage.
6. Cost of operation shall not exceed 40 cents a ton.
7. All refuse and garbage will be incinerated to innocuous ash and vitreous clinker.

8. Will erect and complete said incinerator and temporary building enclosing same, supply all tools and equipment for operation, and furnish complete plant, consisting of one unit of the Sparks Garbage Incinerator, in perfect working order, for the sum of \$6,000, to be paid upon the conclusion of satisfactory operating tests and delivery of maintenance bonds. Will also furnish bonds in good solvent surety company for fulfillment and performance of contract, also for maintenance and to save City harmless from all claims of any nature.

This type of incinerator is stated to be in successful operation in Memphis, Tennessee; Little Rock, Arkansas; Hillsborough, Texas, and Bartelsville, Oklahoma.

While Mr. McKay states that it has proven itself to be the most economical and sanitary garbage incinerator ever constructed in the United States, it is probably another of the type of incinerators that work very well for small quantities of refuse to be destroyed, and offensive gas and smoke are then probably in such small quantities that no serious objection to its operation are apparent.

Fred P. Smith, Henry E. Monroe and R. F. Harding. These gentlemen, under date of November 15, 1915, made application for a franchise for disposal of garbage, rubbish and waste matter for a term of 35 years. In consideration of such a franchise they propose to dispose entirely of all refuse delivered to them as collected by scavengers or others, without cost to the City, and in a clean and sanitary manner. As compensation for such a franchise they offer to pay to the City 4 cents per ton for all refuse delivered to the plant and at termination of franchise period of 35 years they will convey to the City all right, title and interest in a complete incinerating plant, which shall have a capacity of 1,200 or more tons per day, together with a site of not less than 30,000 square feet area. The estimated marked value of said plant and site will be about \$730,000. It is estimated that under the proposed franchise the City would receive about \$237,000 in cash, which, with the estimated value of the plant and the site, would equal approximately \$1,000,000 to be received by the City as compensation for the franchise.

The proposed site to be furnished by Messrs. Smith, Monroe and Harding is in the Islais Creek District within 2,000 ft. from the Islais Creek Incinerator erected by the Destructor Company.

Smith, et al, are to have the exclusive permission, privileges, rights and authority to dispose of all garbage, refuse and waste, except dead animals and swill from restaurants and hotels, which are now otherwise provided for, to be delivered by scavengers, collectors or parties having waste or refuse, and to deliver said refuse to the proposed plant at such hours of the day and at such places as directed, subject to the approval of the Board of Public Works and under the sanitary supervision of the Board of Health, and scavengers or others are to pay, upon delivery at the incinerator, at the rate of 60 cents per ton for all refuse delivered, and the City shall not permit the use of other places for dumping or disposal of refuse.

The Company (Smith, Monroe and Harding) shall become responsible for the disposal of all refuse in such manner that no form of nuisance can result

from the handling, from the treatment or from incineration, and there shall be no noxious odors or gases, smoke, fumes or vapor, either inside or outside of the plant.

The Company proposes to have the plant of the Sanitary Reduction Works turned over to them by the City and that the City shall permit its operation by the Company for the period of the first 18 months of the proposed franchise period of 35 years, or until the new incinerating plant shall be finished. The Company will make such alterations and additions to the present Sanitary Reduction Company's plant as required to remedy existing nuisances of smoke, odor, and general uncleanness. All their work of construction of new plant and the operation of the old plant shall be under the supervision of the Board of Public Works and the City Engineer, and all work of disposal of refuse and garbage shall be under the supervision of the City Board of Health.

The City shall have the right to terminate the franchise at any time after 5 years of operation of the new incinerating plant and for such termination the City shall pay to the Company the sum of \$20,000 for each unexpired year of the 35 year franchise.

Messrs. Smith, Harding and Monroe, under date of December 9, 1915, proposed as follows:—

For the immediate and temporary disposal of waste and refuse they will receive all refuse such as is now taken by the Sanitary Reduction Company and dispose of same upon submerged property owned or controlled by the Company (Smith, Harding and Monroe) in the Islais Creek District. For this privilege they agree to pay to the City the sum of \$20,000 per annum, or \$30,000, for a proposed contract period of 18 months, they to be authorized to collect 60 cents per ton from scavengers who shall deliver the refuse subject to the direction of the Company. All of the physical properties of this disposal are to be subject to the approval of the Board of Public Works and the sanitary and health conditions subject to the approval of the City Board of Health. The Company States that they are prepared to begin operations four weeks after the acceptance of their proposal.

Messrs. Smith, Harding and Monroe, under date of December 9, 1915, also make application for a contract for the disposal of refuse for a term of 25 years, the compensation to the City for said franchise to be 4 cents per ton of refuse delivered by scavengers to the Company (Smith, Harding and Monroe) during the first 5-year period, 5 cents per ton of refuse delivered by scavengers to the Company for the second 5 years of the period of the franchise, and an increase over the 5 cents per ton of 1 cent for each ton of refuse delivered by scavengers to the Company during each succeeding 5-year period for all refuse delivered to the plant. At the termination of the franchise period of 25 years, the Company will convey to the City all right and title in the complete plant, together with the site of not less than 36,000 square feet area, and the estimated value of the plant and site will not be less than about \$730,000. The capacity of this plant will be 960 or more tons per day.

Under the proposed franchise it is estimated that the City would receive not less than \$327,000 in cash, which, together with the value of the plant and site, would be more than \$1,000,000, which the City would receive as compensation for the franchise. The proposed site of the incinerator is in the Islais Creek District on land now owned by the petitioners. All waste shall be delivered to the plant by the scavengers, who shall pay the Company 60 cents per ton for receiving same and the Company shall then become responsible for the disposal of the refuse without nuisance or offensive conditions of any sort, subject in all its operations and results to the approval of the Board of Public Works and the Board of Public Health.

During the first 18 months of the franchise period the Company proposes to receive and dispose of the City's waste by burial for filling purposes at the plant site.

The new plant will be constructed and supplied complete with all equipment for the requirements of the City, ready for successful operation, within 18 months after granting the franchise. It is not proposed to build at the first a plant larger than may be required to dispose of from 500 to 600 tons daily, but further units of furnaces will be built by the Company in advance of the City's requirements and before the end of the franchise period the Company undertakes to have built an incinerator with furnaces of a sufficient capacity to dispose of 960 tons or more, all enclosed in a building of Class "A", reinforced concrete construction. The estimated cost of the completed plant, as proposed by the Company, to be erected under the franchise at any period after the first five years of the operation of the new plant by paying to the Company a forfeiture price of \$24,000 for each unexpired year of the franchise period.

Messrs. Smith, Harding and Monroe, under date of December 9, 1915, propose what they term a feasible method of immediately and temporarily disposing of refuse without investment of any City funds, and for which they are willing to enter into contract with the City.

It is proposed that the present plant, now operated by the Sanitary Reduction Company, be turned over to the Company (Messrs. Smith, Harding and Monroe), and that the scavengers shall continue to deliver the refuse at the plant and pay the reduction charges of 60 cents per ton, as is the present rule.

1. The Company will make such improvements to the Incinerator, to such extent and in such manner that the nuisance features of smoke and dust shall be abated. As compensation for such improvements they agree to accept the profits to be made by the operation of the plant for one year, the profits consisting of the difference between the actual cost of operating the plant and the 60 cents per ton to be paid by the scavengers upon delivery of refuse. After the first year's operation by them they propose to pay to the City the sum of \$20,000 per annum for the continued use of the plant and for such period as the City shall desire and permit its operation.

2. The Company proposes a contract for the operation of the plant under 5 years franchise period and without payment to the City of any sums annually or otherwise, they will entirely reconstruct the present plant, should it be turned over to them, in such manner that its capacity will be increased and all nuisance features of smoke and odor will be entirely abated, and the present congestion of scavenger wagons at the busy times of the day will be entirely abolished. Under the proposal for the 5-year period, it is assumed that the present site for waste disposal purposes will not be considered for a period of longer than about 5 years.

3. The Company (Messrs. Smith, Harding and Monroe) offers to dispose of the City refuse for a period of from 18 months to 2 years by receiving the refuse delivered by scavengers on their Islais Creek property and disposing of same by burial in the submerged district, and for this privilege the Company will pay to the City the sum of \$20,000 per annum so long as this method of disposal shall be permitted.

Referring to the first proposal by Messrs. Smith, Harding and Monroe, for a 35-year franchise period, it will be noted that they propose to pay to the City the sum of 4 cents per ton for all refuse delivered to the plant and they estimate that at the end of the franchise period the refuse that will be delivered by scavengers will amount to between 900 and 1,000 tons per day. This would represent an average income to the City at 4 cents per ton, of approximately \$9,000 annually during the entire franchise period of 35 years.

It will be noted that for the first several months of the period the refuse to be delivered by the scavengers is to be disposed of on what is now submerged land, by process of burial. There are many objectionable features to such a process as will be mentioned more particularly later on in this report, and while Messrs. Smith, Harding and Monroe propose to treat the fill in a perfectly satis-

factory and sanitary manner, they also recognize the fact that the whole foundation of the plant must be built and sustained on piling in order to carry the heavy building and furnace, which furnace, being of brick-work, will certainly require a very stable foundation, in order to prevent it developing cracks and thereby becoming subject to continual repairs.

Another feature requiring consideration would be the difficulty of compelling scavengers to deliver all of the refuse to the Islais Creek District. It would probably be necessary to have one or more receiving stations for refuse in some one or more sites to be determined, to which the scavengers would deliver their refuse. From these receiving stations the refuse could be delivered to the site of the proposed incinerator by motor trucks. The expense of this haul from the receiving stations to the incinerator would probably fall on the incinerator company, and it may be they have included this in their estimates of cost. Their propositions do not make mention of such cost, however, and it may be subject to another franchise or expense item, that either the Reduction Company or the City or the scavengers would have to meet in some manner to be arranged.

It is understood that the kind of furnace proposed by Messrs. Smith, Harding and Monroe is the same furnace or a modification of same that is now in operation in the City of Portland. There is also another one in operation in the City of Pasadena and one of small capacity in use in the City of San Jose, California. It is stated that the operating costs of the Portland plant are something less than 50 cents per ton. With the local charge of 60 cents per ton to be paid by the scavengers, there would be indicated a fair profit on the general operation of the plant.

One advantage that might be mentioned in one or other of the propositions from these gentlemen, is the fact that they propose to relieve the City immediately of further trouble with reference to its disposition of refuse and to guarantee that when their incinerator is built and in working order, it will be entirely satisfactory in that there shall be no offensive odors, dust or smoke, and at all times the operation of the plant shall be under the direction and supervision of the Board of Public Works and the Board of Public Health of the City and County of San Francisco.

A. G. Boggs, under date of November 12, 1915, submits two propositions:

Proposition No. 1. The City shall acquire the present plant now operated by the Sanitary Reduction Company and turn same over to Mr. Boggs, that he may have the unobstructed possession of the plant, with the privilege of operating same until the completion of a new plant which he proposes to build. This plant comprises an entirely new process for purposes of refuse reduction. It is called the "Boggs-Carson Multiple Unit Destructor" and consists of a series of furnace chambers or cells into which the refuse is charged. These cells are arranged in series and the heat and gases from one cell pass into the next and so on through the series, completing the destruction of the refuse by a complete round of operation; the whole process being self-contained does not permit of any odors or smoke passing from the furnace units in the destruction of the refuse.

No furnace of this type has yet been constructed for operation in practical destruction of refuse. It is understood that the inventor and owner have built a plant for experimental purposes, but nothing of a completely practical size.

The proposition states that the multiple unit plant shall be absolutely fumeless and odorless, and sanitary in every respect. When the proposed new plant is completed and with sufficient capacity to handle all the refuse of the City, the present old plant now operated by the Sanitary Reduction Company will be removed by the Contractor without expense to the City, other than a franchise or contract granting the same privileges now granted to the Sanitary Reduction Company. In compensation for the franchise to be granted by the City, Mr. Boggs agrees to pay to the City \$15,000 at the end of the first year after receiving

possession of the property, \$20,000 the second year, \$25,000 the third year, \$30,000 the fourth year, and \$35,000 for the fifth year and each year thereafter up to and including the 30th year, which 30 years shall represent a franchise period requested by Mr. Boggs in consideration for his payments to the City and for the supply of his incinerating plant complete and the removal of the present plant without further expense to the City.

The City shall have a right to terminate the franchise and take over the entire plant at any time after it is in full operation, by paying an amount to the Contractor on which the net annual earnings show a 10 per cent profit. Should the City not desire to terminate the franchise and take over the plant until the end of the franchise period of 30 years, the entire plant is then to become the property of the City without any compensation to the Contractor.

Proposition No. 2. Mr. Boggs proposes to dispose of the refuse of the City by the same method and on the same terms and conditions as proposed by Mr. Richard Schmidt, except that payments to the City shall be 12 cents per ton of refuse delivered by the scavengers and with the further exception that the City shall have the right to terminate any contract made with Mr. Boggs in this matter on a 6 months' notice and a payment of twice the amount of the net profits that can be shown for the previous year's business of disposal.

With reference to the Boggs-Carson Multiple Unit Destructor, as mentioned above, there is no incinerator of this type in practical operation. The chemical actions and re-actions in the process, as described by Mr. Boggs and Mr. Carson, might seem to offer at least a partial solution for the destruction of garbage and refuse, but it is impossible to form an opinion of the practical results to be obtained without some demonstration of the principal features involved in the whole process of the destruction of refuse.

Mr. Boggs' Proposition No. 2 is to be considered with reference to the proposals for burial of garbage which are commented on later in this report.

Fred Linderman, under date of July 22, 1915, proposed to accept all refuse from the scavengers as at present handled by them, and he will convey and load same on his vessels at any selected point or points, collect charges from the scavengers of 60 cents per ton, pay the wharfage charges for vessels and assume the whole responsibility for the disposal of the refuse at sea for the sum of 58 cents per ton, covering a contract for not less than two years and a minimum quantity of 400 tons per day.

It was proposed to use similar equipment to that employed in his contract with Oakland and Berkeley. Owing to the fact that the vessel employed by Linderman in his contract with Oakland and Berkeley for the removal of the refuse to sea was recently wrecked, it is probable that this proposal by Mr. Linderman lapses.

It is not known whether the vessel employed by the Contractor to carry the refuse from Oakland and Berkeley actually complied with the State law which was amended about three years ago, to the effect that garbage may be dumped into the Ocean at any place not less than 20 miles from land, but from a number of complaints that have resulted from time to time it is probable that much of the material was dumped within less than 20 miles from land.

E. G. Borden, under date of December 3, 1914, offered to build a complete destructor of 50 tons capacity, free of cost to the City on site to be selected and supplied by the City. The Contractor will guarantee absolute combustion, free from all gases escaping into the atmosphere. After definite proof of the satisfactory operation of the incinerator the Contractor will sell to the City the original plant at its cost and charge the sum of \$50,000 for the use of the patents under which the incinerator is built, during their lifetime.

This incinerator is a product of the Hydro-Vacuum Smelting Company, built under what is known as the Heslewood patents. During this last summer one of these furnaces was built as an experimental plant at the John Finn Metal

Works, 384 Second Street, this city, and a trial of this plant was made in October, 1915.

The plant is an experiment in the design, construction and operation of a special closed top furnace of the iron smelting type to treat sulphide or other so-called rebellious ores and is connected with a condensing and wash-water apparatus for washing the waste gases and products of combustion from the cupola in such manner that objectionable odors shall be removed from the escaping gases and any valuable by-products may be saved. It was considered by the Company to be a practical method for destroying refuse and the experiment was to try out this possibility. The experiment showed that garbage can be destroyed in a furnace of the type used, but it did not demonstrate that the waste gases may be so purified or cleansed that the escaping vapors shall carry no odor. This is not to say that the waste gases may not be cleansed of odor or other objectionable features by some modification or extension of the process employed by the Company, but is simply a statement that the washing or cleaning operation as employed in the experiment was not effective.

The expense of operating this experimental plant was not a satisfactory basis upon which to estimate probable working costs for a commercial plant. It can be said of this as of a number of other untried processes that it will be necessary to make experiments on a more nearly commercial scale to show what actual costs may be. As above stated, the process applies primarily for the reduction of rebellious ores and since the time the proposition was made it is understood that Mr. Heslewood is not particularly interested in the application of his furnace for the destruction of garbage.

The City Disposal Company, Joseph F. Lahaney, President and Manager, under date of May 12, 1914, asks for an opportunity to bid upon a franchise covering the disposal of garbage or swill.

San Francisco Disposal Company, Charles Turner, President and General Manager, under date of June 23, 1914, made a proposition to the City as follows:—

In the first place it will be necessary to have a separation of the waste materials of the source, that is to say, at the households—one receptacle for garbage or swill and another for general rubbish or waste. They assume that about one-third of the total refuse collected in San Francisco, or about 150 tons per day, is garbage or swill. They proposed to receive and dispose of garbage from 150 to 200 tons daily for a period of 10 years, requiring the right to charge and collect from scavengers 60 cents per ton for all garbage delivered, and they will obligate themselves to take care of all garbage produced during the period of contract and will give satisfactory option to the City to buy the plant at any time during the franchise period. The Company makes no proposal for disposition of general waste, merely suggests that it can be destroyed in the present plant now operated by the Sanitary Reduction Company.

The San Francisco Disposal Company's plant is located in Butchertown, at Evans Avenue and Keith Street. This company now takes the swill from hotels and restaurants in the City and the method employed for disposal is that known as the reduction process which recovers from garbage commercial products such as grease and fertilizer. The communication also suggests the rebuilding of part of the old plant of the Sanitary Reduction Company and putting it in better shape for destroying waste.

Richard Schmidt, under date of December 17, 1914, and subsequently under date of December 8, 1915, through his attorney, Hiram W. Johnson, Jr., submits a proposal for the receipt and disposition of refuse, waste and garbage in amounts up to 500 tons daily, excepting such garbage as the City may desire to incinerate in its own plant, requesting a franchise period of 35 years during which time there shall be paid to the City nothing for the first 3 months, 2 cents per ton for the second three months, 3 cents per ton for the third 3 months,

and 4 cents per ton for the fourth 3 months of the first year, and 4 cents per ton for all time thereafter during the life of the franchise.

Mr. Schmidt, through his attorneys, submitted a proposal of agreement for consideration, as follows:—

1. That all refuse and garbage shall be collected by scavengers and delivered by them at such places and during such hours as may be designated by the City Engineer, and the Contractor shall be authorized to charge and collect from scavengers for receiving and disposing of the waste the sum of 60 cents per ton.

2. The Contractor shall receive such refuse at the places and times designated and convey and dispose of it or deposit same in cars and remove to the place of final disposal within 24 hours after having been delivered by the scavengers.

3. The Contractor shall dispose of the refuse by dumping on waste land in such manner that it shall be sanitary and shall be treated by a privately owned process of Mr. Schmidt in such manner that it will not become a nuisance. The places for fills or dumps within the City and County shall be approved by the Board of Supervisors and no salvaging shall be conducted except on the fills and dumps.

4. All notices or directions to Contractor, except orders or ordinances from the Board of Supervisors, shall be in writing.

5. Contractor shall have the right at his option to enclose the places for dumps or where fills are being made and may prevent unauthorized persons from entering upon such dumps.

6. The Contractor shall enter upon the performance of this contract within 90 days after execution of agreement and shall continue the disposal of all waste during the full term of agreement.

7. The Contractor shall execute a bond in a sufficient sum to guarantee faithful performance of the contract, and the bond shall indemnify the City against all damage to person or property by any act of Contractor, except such acts as are authorized or approved by the City, and the bond shall also indemnify the City against liability to employes of the Contractor.

8. If, for any reason, other than may result from the fault of the Contractor, the refuse delivered by the scavengers shall be reduced to less than 200 tons per day, the Contractor shall not be required to pay anything to the City, or should the amount be reduced to less than 100 tons per day, the City shall be obliged, at the option and request of the Contractor, to purchase all physical appliances and structures employed in the disposal of such refuse at a reasonable value to be ascertained by appraisal, and this reasonable value shall be paid in full satisfaction of contract or franchise.

The terms proposed by Mr. Schmidt, upon which the City, at the option of the Contractor, shall take over the plant and the business of the Contractor, state that the valuation shall be ascertained in the following manner:—

The City shall pay to the Contractor a sum of money equal to 10 times the amount of the net profits from the Contractor's operations for the 12 months next preceding the period when the City began to operate its own plant and if taken over by the City after 25 years immediately succeeding the date of contract the payment to the Contractor shall be equal to a sum of money which shall be 9 times such net profits if taken over by the City during the first year succeeding the 25-year period, or 8 times if taken over during the 27th year, 7 times if taken over during the 28th year, and so on until the amount to be paid the Contractor shall be diminished by one for each year until the 9th year succeeding the 25th year period, which 25 years shall be the 25 years immediately succeeding the date of contract.

These prices are based upon the assumption that the City shall take over and operate the plant and business of the Contractor, conducting it in practically

the same manner as proposed by the Contractor, but in the event that the City should take over the plant for the purpose of discontinuing the operation under the terms of the franchise and does not intend to use the plant or the method or should decide to enter upon a plan for the disposal of refuse essentially different from that under the operations of the franchise, then the amount to be paid the Contractor shall be the amount previously mentioned less the appraised valuation of the physical property and appliances which the Contractor may retain. Should the franchise be permitted to run for the full term of 35 years, the whole plant shall then become the property of the City without any payment whatsoever therefor, and it may take immediate possession.

Mr. Schmidt's attorney, under date of December 8, 1915, submitted some variations in the detail of the original proposals to the general effect that Mr. Schmidt would consider—that the franchise period of 35 years mentioned could be changed to 5 years or any other term that would be acceptable to the Board of Supervisors, so that a shortening of contract term should fit into proposal as originally made.

2. The location of the ground or the area into which garbage is to be dumped will be under the complete supervision and approval of the City authorities.

3. Sanitary inspectors shall be appointed in any reasonable number, one-half of expense to be paid by the Contractor.

4. Mr. Schmidt will give bond in any reasonable amount for faithful performance of work and any change in the proposal or terms of the proposal along fair and equitable lines or any change to meet objections that may be made in regard to the proposal will be met by Mr. Schmidt.

In this connection I would refer to the report made to the Board of Public Health by Dr. Hassler, the Health Officer, under date of November 9, 1915, which refers particularly to the proposition submitted by Mr. Schmidt:

"This plan of disposal is open to the following objections:

"1. The character of the receiving stations, class of construction, whether enclosed or open, the provisions of cleansing and sterilization, provisions for authority and inspection with payment for inspectors are all overlooked; likewise no consideration has been given the question of rats, flies, vermin, odors and the general nuisance to the neighborhood.

"2. At the several receiving stations there must be an aggregate of from 40 to 60 ordinary freight cars standing open all day long, for the agreement permits the retention of refuse at the receiving stations for a period of twenty-four hours, which means these stations need never be free from garbage.

"3. These receiving stations will be designated by the City Engineer and the City, therefore, becomes a partner with the Contractor in maintaining what at any time may become a public nuisance.

"4. The final disposal is to be by dumping and burial. Dumping and burial of garbage is a bad practice for the reason that it means a putrefying, offensive mass that in spite of the covering will give rise to foul odors and retard the installation of permanent improvements for a long period of time. In all places where garbage has been used as a fill and the site subsequently used as a place of business or residence, it is a matter of record that the incidence of communicable disease is greater among those residents than in other sections. Such fills are also a natural harboring and breeding place for rats, flies, vermin, etc.

"San Francisco, with its plague experience, must always guard against the creation and maintenance of rat harbors, and I believe that it would be impossible to cover a fill of garbage with a sufficient amount to earth to properly neutralize the inherent dangers of putrefaction and prevent a nuisance.

"The agreement states that the Contractor is to cover with a thin layer of earth, but there are no specifications as to the amount, character or composition

of earth to be used, not any length of time as to how long dumped garbage may lie exposed before covering with earth. Likewise there is no provision for authority of inspectors over the contractor nor for the payment of inspectors representing the City. When it is considered that a day's refuse of San Francisco will cover from one-fourth to one-third of an acre to a depth of six feet, the insufficiency of the agreement is very evident.

"Note:—The matter of disinfecting garbage by spraying with a solution as suggested by one of the parties interested in obtaining a contract is not a practical procedure for abating the noisome odors or the nuisance which might arise from rats and flies, for the reason that unless the garbage is thoroughly saturated it would be absolutely ineffective, and saturation with a disinfecting solution delays the organic decomposition and final destruction of the garbage.

"5. As a form of agreement, it is all in favor of the contractor, the City becomes a partner by designating the sites and in my judgment becomes liable for damages if case adjacent property is injured by reason of the dumps.

"The City guarantees the Contractor the privileges of his contract and agrees to give the Contractor all the wastes of, or to be collected by the City (see paragraph 9) and failing to do something it cannot do the City would be liable for damages to the Contractor. The City is to be paid a certain sum per ton, but makes no provision for payment of weighers, clerks, inspectors, etc., in order to check and record the tonnage.

"6. In the ninth paragraph there is a definite statement that no ordinances, sanitary regulations or requirements shall abrogate the provisions of the contract.

"7. A final paragraph refers to default of contractor to perform his duties, but nowhere are his duties defined, except in the haziest possible manner. The franchise is to run for thirty-five (35) years and can only be terminated by the City constructing and municipally operating its own incinerating plant.

"It must 'construct' its own incinerating plant.

"It must municipally operate its own plant.

"It must be an incinerating plant and no other means of disposal.

"Even if it does all these things, it can resume control only by paying many times the 'net profits' of the contractor, while 'net profits' are to be the basis of purchase there is no provision for securing a check upon the Contractor's own figures".

I am in accord with Dr. Hassler, wherein he states in the concluding paragraph of his report as follows:—

"I feel assured that any garbage dumped would be looked upon with considerable suspicion and disfavor."

I also quote from a statement of Calvin S. White of the Oregon State Board of Health, wherein he writes, under date of November 2, 1915, as follows:—

"I am most vigorously opposed to any fills or permanent improvements being made from garbage. The plan, I understand, has been tried out in Seattle and pressure has been brought to bear on the local health authorities by those interested to endorse the measure, although now I think it has been discontinued there. It was tried here in one of the gulches for a few weeks, but the well-founded complaints of all the people living in the neighborhood was sufficient to have it stopped. It is a breeding place for rats and flies, gives rise to foul odors, no permanent improvements can be built over such a fill without handling the putrified mass and in my judgment cannot but be a source of contamination. My own opinion is that the only way to dispose of garbage is to take all that is fit for fertilizer back to the land and have the rest incinerated. It is true in our City and perhaps in yours that there is not sufficient demand to warrant the saving of by-products such as grease, soap, bones, etc., and the waste of paper that cannot be used over is of course considerable, and at the present time the only plan I would endorse would be one that had the total destruction of all putrefactive material as its prime object".

These same remarks apply to the alternative proposal of Messrs. Smith, Harding and Monroe, to Proposition No. 2 of A. G. Boggs, and particularly to the alternative of the proposition from Fred Linderman, the alternative being the periods where the City might be compelled to dispose of its refuse by burial when it would be impossible for the vessel to carry the refuse to sea at periods of storm or weather stress, or a recurrence of the present disaster. Oakland has been compelled to resort to fill in low lying land and the authorities are finding themselves in an unpleasant situation. Berkeley, I understand, has been compelled to start its own incinerator even though it has to be run at considerable loss.

The Harris Municipal Garbage Incinerator and Steam Generator Company, under date of November 15, 1915, submit plans and specifications for incinerator and steam generator. This concern proposes to furnish plans and specifications and a supervising engineer at an agreed-upon price, and the City is to build the plant at its own expense. Should the guarantee of inoffensive and satisfactory operation not be met there would be no charge for services, and plans, etc., but should the guarantees be met the City should pay to J. B. Harris a royalty of \$50 per ton of plant capacity as total final royalty—for example, 600 tons daily capacity of plant, \$30,000 royalty. J. B. Harris guarantees the sanitary destruction of refuse at a profit of approximately 60 cents per ton, after allowing 6 per cent interest on investment, 4 per cent sinking fund for repairs and all labor, but this has to assume a certain profit to be derived from the generation of steam, as otherwise there could be no definite profit in such a plant.

The general type of this plant is somewhat similar to the Decarie Incinerator in that the grates of the furnace consist of water tubes and the arrangement of these water tubes forms a steam generator resembling in a way a Sterling water tube boiler. There does not appear to be any example of this incinerator in operation.

The life of this furnace or incinerator would be the life of the weakest joint in the water tube boiler, and it is a device that cannot be recommended for application.

J. E. Briggs, Pacific Coast Agent of the Decarie Incinerator Company, offers a number of letters giving data on operation and costs of Decarie Incinerators. Also states that he feels certain he can save the City a substantial amount in the cost of construction of an incinerator and also in cost of operation and general efficiency.

The Decarie Incinerator is another with the water tube type of grates, and the same remark applies to this as to the Harris, in that the continuity of operation will depend upon the strength of the weakest pipe joint in the furnace.

Mr. Briggs has no definite proposal to make, however, and it must be assumed that he is only in position to make bids or proposals for Decarie Incinerator should the City undertake to build one or more incinerating plants.

R. E. Tilden, consulting civil and hydraulic engineer, Winnemucca, Nevada, offers for consideration an incinerating plant of the Dixon type with some improvements by W. G. Kirkpatrick of Birmingham, Alabama.

This incinerator is of the small capacity type, well adapted for the smaller towns or where labor and fuel are cheap and where the smoke and odors would be of such comparatively small volume and amounts as to be practically negligible.

The refuse is dumped on the floor and the furnace fed by hand. The whole operation is by hand and the capacity of furnace is about two tons per hour.

A number of these furnaces are said to be in operation in the Southern States—Birmingham, Alabama; Augusta, Georgia; San Antonio, Texas.

Mr. Kirkpatrick's relation to the installation of an incinerator is that of an engineer, solely. He furnishes plans and specifications upon which local contractors bid for the supply and erection of the incinerator. He charges engineering fee, but holds no patent rights. Mr. Kirkpatrick says the plant is no more

objectionable or offensive than a livery stable and does not give out as much odor, and that the objections to this plant being centrally located for convenience of garbage delivery are mostly sentimental, such as not wanting to see the garbage carts passing.

Mr. Tilden is western correspondent of Mr. Kirkpatrick. Mr. Tilden has no proposition to make to the City. He simply offers the design of the Dixon incinerating furnace as modified and improved by Mr. Kirkpatrick for consideration here should the City decide to erect any plants of its own.

It will be noted that each proposition contains a guarantee of operation that the proposed method of disposal will be inoffensive, odorless and otherwise unobjectionable.

Messrs. Collins & Pellett propose to guarantee "by an acceptable bond that their incinerator will be without any offensive odors or gases and practically smokeless in operation".

Neil H. McKay will furnish bonds in a solvent surety company for the fulfillment and faithful performance" of guarantee that "the plant will be odorless and inoffensive".

Messrs. Smith, Harding and Monroe say: "No nuisance or offensive conditions such as noxious odors or gases, dust, smoke, fumes or vapors shall be caused by the process or means of disposal to exits or prevail inside or outside the plant", and "there shall be no heavy nor offensive smoke from the chimney at any time from burning refuse." Regarding the proposed reconstruction of the plant now operated by Sanitary Reduction Company, they will "increase its capacity and all nuisance features of smoke, dust and odor will be entirely abated".

Mr. Boggs says his "multiple unit plant shall be absolutely fumeless and odorless and sanitary in every respect".

E. G. Borden will "guarantee absolute combustion with no escaping gases".

Richard Schmidt proposes to handle the refuse in a manner "that shall be entirely sanitary and shall be treated to prevent same from becoming a nuisance", and "will give a bond in any reasonable amount" for satisfactory performance.

J. B. Harris "guarantees" inoffensive and satisfactory operation by the use of his system.

It appears to be the custom among promoters and sales agents and manufacturers of incinerators to offer guarantees for the successful and satisfactory operation of their several plants, and it is possible that much of their optimism is based on the hope or expectation of being able to "get away with it". Unfortunately however, there are numerous instances of application where success has not been achieved.

The general and most recent history of the treatment and disposal of refuse in the United States consists of a long line of failures to meet the requirements of the more recently developed sanitary laws and health consciousness. There are reputed to be some successful methods in operation in some of the larger cities and a close hand study of some of these plants would be of value in our further investigation.

To quote from Page 54 of the Final Report of the Grand Jury of the City and County of San Francisco for the term beginning December 16, 1914, and ending December 14, 1915:—

"Apparently the art of incineration is by no means fully developed. An incinerator recently installed at Berkeley has been closed down, and of the four recently constructed in Seattle the use of two has been discontinued. Before the City Engineer can make the logical recommendation as to what steps are to be taken in the treatment of this problem, a comprehensive study should be made of the entire subject of garbage disposal. The most efficient and reliable way of gathering this data is by personal inspection, which will involve the expenditure of about \$2,500. In view of the importance of the problem and the very large expenditures already made by the City of San Francisco, amounting in all to

\$699,000, the wisdom of such a study should be apparent to the Board of Supervisors".

There can be little question that the incineration method is the proper one for the final disposal of refuse, and it must be admitted that the burial or dumping method is of a temporary nature only.

Before being in a satisfactory position to advise upon the numerous propositions submitted, or to recommend any particular design of incinerator, it is desirable, and I recommend, that funds be made available to the extent of \$2,500 to meet the expense of investigating the methods used in garbage disposal in several cities of the United States that have a population of upwards of 500,000.

1908 BONDS FOR GARBAGE DISPOSAL SYSTEM—JUNE 20, 1916.

Memorandum of cash on hand, as per attached statement, not allowing for any further liabilities on account of purchase price of incinerators from Destructor Company.

Total cash on hand.....	\$243,643.63	
From this cash balance should be allowed the following, which will be expended whether the Destructor Company wins or loses suit:—		
Owing to Sanitary Reduction Works on Plant....	\$50,000.00	
To be expended in investigations *during suit and in investigations of various methods of garbage incineration	971.42	50,971.42
		<hr/>
		\$192,672.22
Amount of bonds unsold.....		120,000.00
		<hr/>
Balance on hand after paying liabilities and expenses, but not including further payments to Destructor Company.....		\$312,672.22

GARBAGE DISPOSAL SYSTEM—BOND ISSUE OF 1908.

FINANCIAL STATEMENT, JUNE 20, 1916.

Total appropriations June 20, 1916.....	\$840,110.58	
Total surplus from appropriations to be returned to fund.....	87,678.80	
		<hr/>
Net total appropriations June 20, 1916, including \$50,000.00 due Sanitary Reduction Works	\$752,431.78	
Total bonds sold	\$880,000.00	
Premiums on bonds.....	65,104.00	
		<hr/>
Total amount available June 20, 1916.....	\$945,104.00	
Net total appropriations June 20, 1916.....	\$752,431.78	

(Including amount due but not appropriated for Sanitary Reduction Works)

Net amount available for appropriations on new work, assuming that no more will be paid Destructor Company on their contracts.....	\$192,672.22	
Amount of bonds authorized but not yet sold.....	120,000.00	

Amount remaining in bond fund, after all bonds are sold and assuming no more payments on incinerator contracts.....	\$312,672.22	
---	--------------	--

Amount recoverable from Destructor Co. on account of payments made on incinerators:

Islais Creek	\$ 85,699.51	
North Beach	43,194.26	
	<hr/>	
	\$128,893.77	

(Williams shows a balance of \$155.50 less than shown by this statement.) .

	North Beach	Islais Creek
Contract price	\$132,075.00	\$123,141.00
Paid	43,194.26	85,699.51
	<hr/>	<hr/>
Due Contractor	\$ 88,880.74	\$ 37,441.49

BUREAU OF ENGINEERING

GARBAGE DISPOSAL SYSTEM—BOND ISSUE OF 1908. FINANCIAL STATEMENT, JUNE 20, 1916.

Description of Work	Expended	Required to Complete	Total Amount Required	Appropriation	Surplus
Lot at Islais Creek, Bd. of Supervisors.....	\$ 15,000.00		\$ 15,000.00	\$ 15,000.00	
Lot at North Beach, Bd. of Supervisors.....	80,000.00		80,000.00	80,000.00	
Appraisements and Incidentals, Bd. of Supervisors.....	850.28		850.28	850.28	
Miscellaneous Expenses, Bd. of Supervisors.....	1,735.30		1,735.30	1,735.30	
Grading Islais Creek Lot and Foundation Piers for Building.....	11,951.90		11,951.90	18,000.00	\$ 6,048.10
City Engineer's Salary (part).....	175.00		175.00	175.00	
Water Mains on Kansas St. for Islais Creek Incin.	230.38		230.38	350.00	119.62
Four (4) 60-ton Furnaces for Islais Creek and North Beach Plants.....	141,787.67		141,787.67	260,000.00	118,212.33
Islais Creek Incinerator Building.....	76,781.88		76,781.88	90,000.00	13,218.12
Plans and Specifications, No. 1.....	10,919.37		10,919.37	11,000.00	80.63
Plans and Specifications, No. 2.....	11,566.08	933.92	12,500.00	12,500.00	
Engineer's Investigation in Incinerator Suits in Federal Court.....	462.50	37.50	500.00	500.00	
Sanitary Reduction Works (Lands).....	350,000.00	50,000.00	400,000.00	350,000.00	50,000.00*
	\$701,460.36	\$50,971.42	\$752,431.78	\$840,110.58	\$137,678.80
				Deficit.....	50,000.00
				Net Surplus.....	\$ 87,678.80

* Deficit.

Williams shows expended.....	\$701,615.86
We show	701,460.36
Difference	\$ 155.50

DIVISION OF SURVEYS.

During the past fiscal year a total of 1827 orders for surveys were received at the public counter. Of these 59 were for lot surveys and 1768 were for surveys for public improvements and in answer to petitions or complaints. They include approximately as follows: 5,304 blocks and crossings, a total length of 2,545,920 lineal feet, or 482 miles.

Precise levels were run, covering 1075 blocks and crossings, or about 210 miles; total number of bench marks rechecked and established, 2,505.

Approximate totals are as follows:—

6,379 blocks and crossings, 3,654,720 lineal feet of 692 miles.

Fees collected and turned over to the City Treasurer, \$20,623.25.

Following is a detailed description of the work performed:—

SURVEYS.

Made for	Number	
Public Contracts	526	
Private Contracts	265	
Street Repair Department.....	71	
Division of Sewers.....	121	
Board of Public Works Commission.....	349	
Superintendent of Public Buildings.....	2	
City Architect	8	
City Attorney	1	
Bureau of Engineering.....	424	1767

LOT SURVEYS.

Private Owners	40	
City Architect	13	
Board of Public Works Commission.....	1	
Superintendent of Public Buildings.....	6	60
Total		1827

The following Precise Level Bench Marks were established or reconstructed in the different districts of the City during the fiscal year ending June 30, 1916:—

Districts	Bench Marks
50 Vara	122
100 Vara	177
Mission	467
Western Addition	88
Potrero	614
Richmond	295
Sunset	112
Other Districts	630
Total	2505

Number of miles covered, 210.

In addition to the daily surveys above enumerated, work has been advanced on the following projects:—

Circular Avenue widening.

France Avenue, etc., street extensions.

Surveying for the purpose of connecting or tying together the Potrero and South San Francisco districts, bounded by Oakdale Avenue, Railroad Avenue, Army Street and San Bruno Avenue, including Jerrold Avenue, Evans Avenue and interior streets.

Re-locating and defining the street lines and placing street monuments in streets of Panama-Pacific Exposition grounds.

Twin Peaks Scenic Boulevard (preliminary work).

Making map and checking descriptions of Chenery and Diamond Streets for City Attorney.

Holly Park District, fixing monument lines.

Market Street Extension, 24th to Stanford Heights, westerly line. (Preliminary work).

San Bruno Avenue through Bay Shore Tract.

Surveying and establishing grades on Twin Peaks Terrace.

Twin Peaks Boulevard Extension (Park Hill Avenue), locating improvements, cross-sections, profiles, etc.

Judson Avenue Extension.

Phelan Avenue Extension.

San Jose Avenue Widening, locating improvements, buildings, etc., profiles for grades.

Hunters Point Road Survey.

Clarendon Avenue, St. Germain to Ashbury Street.

Surveying, checking monuments, street and monument lines in Geary Street, 12th to 48th Avenue; Fulton Street, 12th Avenue to Great Highway; and 16th, 19th, 26th and 47th Avenues between Geary and Fulton Streets.

4th and 5th Avenues, California and Cornwall Streets, encroachments. (City Attorney).

Spreckels Street, South of Sunnydale.

Edna Street, new street opened between Sunnyside and Melrose Avenues.

FEES RECEIVED FOR SURVEYS.

1915	For Public Improvements	For Private Improvements
July	\$ 1,532.50	\$ 25.00
August	2,079.25	75.00
September	1,479.50	105.00
October	1,840.00	52.50
November	1,446.00	118.00
December	1,578.50	80.00
1916		
January	681.00	50.00
February	1,865.00	80.00
March	1,697.75	25.00
April	2,094.00	166.70
May	1,837.05	127.50
June	1,500.00	87.50
	<hr/>	<hr/>
	\$19,631.05	992.20
		19,631.05
		<hr/>
Grand total		\$20,623.25

CURRENT WORK ON HAND.

The following orders for surveys for public improvements are now on our books:—

Mission District	3
50 Vara District	5
100 Vara District	4
Potrero District	7
Richmond District	9
Sunset District	5
Western Addition	3
Homesteads	15
	—
Total number of orders.....	51

Orders average about three blocks per order, making a total of about 153 blocks plus the crossings.

To keep up the current work with the annual budget allowance is indeed a most difficult task. Yet, we are expected under the annual budget allowance to carry on all special projects and restoration work without additional funds.

The amount of current work performed under public and private contracts for the improvement of public streets, parks, etc., during the last ten years, from April 18, 1906, to July 1, 1916, has reached the enormous sum of \$13,195,907, about 1½ millions per year. This one item alone (current work) has required surveys covering 52,187,520 lineal feet. The fees collected and turned into the City Treasury for said work amounts to \$211,572.45.

The current work at the present time is far in excess of any time since the fire of 1906, and does not include any special projects or restoration work.

TESTING LABORATORY.

It has been found expedient and economical for the Bureau of Engineering to conduct its own testing laboratory. Here are tested samples of all materials used in City construction, including asphaltum, building and paving brick, steel, bronze and cast iron, cement and concrete, paint and oil, rock, sand and water.

In February, 1916, the laboratory was moved to the new City Hall, where larger quarters have been provided in a location in the basement, easily accessible for the delivery of heavy samples, and where a firm foundation for the heavy testing machines was obtainable.

Expenditures for chemicals and supplies during the past year amounted to \$583.75, and the total cost of operating the laboratory, including purchase of materials, amounted to \$5,383.75. The total number of tests completed during the year amounted to 8329.

YEARLY REPORT TESTING LABORATORY, BOARD OF PUBLIC WORKS, FISCAL YEAR 1915-1916.
SHOWING THE CHARACTER OF THE MATERIALS AND THE TESTS MADE.

No.	Material	Tests Made	—1915—					—1916—					Totals		
			July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April		May	June
1	Asphaltum.....	Penetration.....	20	66	55	96	52	52	18	29	18	42	58	70	576
2	Asp. Surf.....	Analysis.....	136	188	172	230	128	130	40	72	48	156	120	156	1576
3	Brick, Bld.....	Compression.....	6	16	9	12	12							9	64
4	Brick, Pav.....	Rattler.....	7	5	9	18	15	12		12	12	6	14	12	122
5	Bronze.....	Tension.....	28	4										12	44
6	Bronze.....	Compression.....					4	6							10
7	Cast Iron.....	Cross Bend.....		28	40		4							28	100
8	Cement.....	Strength, etc.....	306	162	90	261	396	450	216	261	315	324	378	495	3654
9	Concrete.....	Chemical.....												3	3
10	Creosote.....	Chemical.....				4									4
11	Concrete.....	Compression.....	4			16				9	12	4			45
12	Gal. Pipe.....	Chemical.....		8									24	13	45
13	Gasoline.....	Distillation.....					8								8
14	Lime Hyd.....	Soundness, Fine.....	1	5	4	6	6	6	3		6	4	4	4	49
15	Linoleum.....	Physical.....		8											8
16	Lub. Oils.....	Physical.....	7						4						188
17	Paint.....	Chemical.....				4					12	8	6	6	36
18	Rock.....	Grading.....	8	10	14	12	12	16	8		8		12	8	108
19	Sand.....	Fineness.....	12	10	10	16	16		16		12	16	16	12	136
20	Soap.....	Chemical.....				5								6	11
21	Soil.....	Chemical.....										51			51
22	Steel.....	Bending.....	72	60	36	25	36	52	22	75	96	60	141	40	715
23	Steel.....	Tension.....	72	60	38	25	32	48	25	75	96	69	144	40	719
24	Terne Phe.....	Chemical.....							20						20
25	Water.....	Chemical.....	4										4		8
26	Wire.....	Chemical.....								9	9				18
Totals.....			683	630	472	738	713	772	372	542	644	740	921	1102	8329

PHOTOGRAPHIC AND BLUEPRINT DEPARTMENT.

The work of the Photographic Department connected with the Bureau of Engineering has been considerably broadened during the past fiscal year. Heretofore most of the work was performed for the Bureau of Engineering but arrangements have been perfected whereby any department of the City government can have photographs made at cost by the Engineer's photographer.

The photographic laboratory has been installed in specially designed quarters on the roof the new City Hall. Equipment of the latest type has been added and the results obtained have proven that the policy of the City doing its own photographic work is economical.

The great advantage that accrues to the City from having this bureau is that plans of contemplated improvements, can be safeguarded better than if the work were done by outside photographers.

~~Following is a detailed report of the work done during the past year:~~

ANNUAL REPORT
OF THE
Bureau of Engineering
TO THE
Board of Public Works
City and County of San Francisco
FOR THE
Fiscal Year ending June 30, 1917

M. M. O'SHAUGHNESSY
CITY ENGINEER



Annual Report of the City Engineer

1916-1917

CITY AND COUNTY OF SAN FRANCISCO

DEPARTMENT OF PUBLIC WORKS, BUREAU OF ENGINEERING

San Francisco, December 6, 1917.

To the Honorable

The Board of Public Works of the
City and County of San Francisco.

Gentlemen: Herewith is transmitted the annual report of the Bureau of Engineering, for the fiscal year 1916-1917.

The development of the Boulevard System has been actively advanced during the past fiscal year. The Marina Boulevard, marked at intervals with gems preserved from the Panama Pacific Exposition, is now an assured fact. Camino del Mar has been extended into the Presidio, over an ornamental concrete viaduct constructed by the United States Government in co-operation with the City and County of San Francisco. The Esplanade has been extended as far as the limited appropriations for this improvement would permit. Twin Peaks Boulevard has been completed and Hunters Point military road is well under way. The last named thoroughfare will do much toward developing manufacturing industries in the southeasterly portion of the City, and will afford direct access to the Hunters Point dry dock and naval base, which the Government will construct in the near future. Plans have been developed for the Telegraph Hill Boulevard and the regrade of Rincon Hill. The policy of overcoming the defects of the rectangular street system in hilly districts has been pursued, and notable accomplish-

ments in this direction have been the regrades of Cumberland, Noe and Sanchez Streets.

More pavements have been constructed within the past fiscal year than in any similar period since the memorable fire of 1906. A new type of pavement has been introduced, namely the so-called vertical fibre vitrified brick monolithic type. Its chief advantages over the older vitrified brick pavement for steep hillsides are its cheapness and ease of construction. Another advance in this line has been the adoption of "Topeka" surface, a semi non-skid sheet asphalt pavement. With the enormous urban automobile traffic of the present time, such a pavement has become a necessity. Six hundred and sixty-nine thousand, three hundred and sixty-five square yards of pavement of all types were laid during the past fiscal year.

The Municipal Railways, which, despite the pessimistic predictions of opponents of the system, have proven a great financial asset to San Francisco, have been developed along logical lines during the past year. The Church Street line has been completed and is earning dividends. The Twin Peaks Tunnel line will be completed during 1917, and a direct means of access provided before many months from the ferry to the districts beyond Twin Peaks.

On April 5, 1917, crews working on the east and west headings of Twin Peaks Tunnel met underground, 6,000 feet from the easterly portal. Shortly thereafter the bore was completed. It is conservative to predict that within a few years of its completion, property values to the south and west of the Peaks will advance in value in excess of the total amount paid for the construction of the tunnel. Its construction will also facilitate providing adequate means of transportation to the towns down the peninsula, when adjacent communities see fit to become components of Greater San Francisco.

The principal units of the sewer system completed during the past year comprise an outlet for the west side of the Ocean View district: the Great Highway sewer, extending

from Noriega Street to Lincoln Way; the Glen Park sewer extension; the Stanley Street sewer, and the Oakdale Avenue sewer. The system will be extended as additional funds become available.

On the Auxiliary Water Supply System, extensions have been provided in the Telegraph Hill district, in Pine Street and in First Street. The many frame dwellings on the steep slopes of Telegraph Hill have been afforded additional protection with an attendant reduction in insurance rates. The rock formation in this district made the excavation work costly. The other two extensions accomplished similar reductions in insurance rates.

The total number of surveys made during the past year were 1838. Two thousand six hundred and one precise levels have been run and bench marks established over a total distance of 180 miles. Fees for these surveys amounted to \$24,712.

In the Testing Laboratory, 6004 tests were made on various structural materials, at a cost, inclusive of salaries and supplies, of \$5529.40. The inspection of concrete paving base has been carried on with the aid of laboratory analyses with a marked increase in the quality of the resultant concrete. Analyses include the theoretical determination of the most economic cement and sand ratio—an exact result hitherto indeterminate, but which by continued research in our Testing Laboratory has been perfected.

Included in the report are maps showing population, area and assessed valuation of all districts of the City and County of San Francisco, and also the type of street pavement in each block thereof.

On the Hetch Hetchy project, construction work has continued interruptedly since my last annual report. The Railroad has been completed with the exception of a portion of the ballasting. The Lower Cherry River Power Development has progressed steadily and will be finished by about January 1, 1918. A reinforced concrete masonry buttressed arch dam is in progress of construction at Lake Eleanor.

The design of this structure involves several original features—one is the placing of the central axes of the arches on a curved arc upstream across the present narrow channel of Eleanor Creek. Tangent to this central arc and extending to the abutments on each side of the present channel, the axes of the arches will lie in planes whose horizontal traces form an angle of 30 degrees. There are 20 arches, each with a span of 40 feet. About 7,000 cubic yards of high grade concrete will be embodied in the structure. Logging and yarding at the City's Canyon Ranch Sawmill for the season's run in 1916 amounted to over 1,600,000 board feet of rough lumber, besides a considerable quantity of surfaced material. During the spring of 1917, over 400,000 board feet were cut and planed. An additional sawmill has been established at Lake Eleanor. This has a capacity of 6,000 board feet per day. A base hospital has been designed and will be constructed at once. All branches of the work are well co-ordinated and advanced as rapidly as possible.

Following is detailed description of the work accomplished in this Bureau during the fiscal year.

Respectfully submitted,

M. M. O'SHAUGHNESSY,

City Engineer.

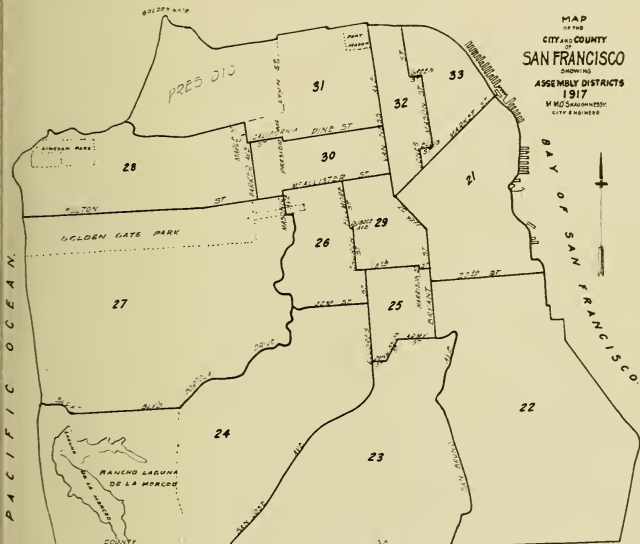


TABLE No. 1.

POPULATION, AREA, AND ASSESSED VALUATION, BY ASSEMBLY DISTRICTS.

DISTRICT	POPULATION			AREA		VALUATION*	
	Total	Per Square Mile of Land	Square Miles of Land	Square Miles of Water	Total Square Miles	Land in Acres	Assessed Valuation of Taxable Land and Improvements
21	36,015	12,955	2.78		2.78	1,779	\$ 89,321,280
22	19,746	2,816	7.00		7.00	4,480	11,639,750
23	32,919	6,330	5.20		5.20	3,325	11,441,380
24	36,888	4,822	7.65		8.23	4,968	15,107,970
25	42,504	46,708	0.91	†0.58	0.91	583	15,550,650
26	57,967	38,645	1.50		1.50	954	19,617,920
27	45,801	5,270	8.69		8.69	5,564	26,136,625
28	53,022	15,687	3.38		3.38	2,165	27,179,275
29	45,228	42,269	1.07		1.07	684	24,186,040
30	46,794	38,044	1.23		1.23	787	23,500,110
31	41,334	9,984	4.14		4.14	2,651	35,580,809
32	65,277	56,273	1.16		1.16	741	55,700,040
33	34,467	28,252	1.22		1.22	779	122,410,660
13	557,962	12,148	45.93	0.58	46.51	29,760	\$477,372,509

* Assessed valuation for taxation is 50% of appraised valuation.

† Lake Merced.

BOULEVARD SYSTEM.

In advancing the policy outlined in previous annual reports of the City Engineer, work on the boulevard system has been actively prosecuted during the past fiscal year. The following is a description of the work accomplished.

Marina Boulevard:

To have permitted the work of salvage to eradicate all trace of the Panama Pacific Exposition would have been a serious mistake, both from an economic and an aesthetic standpoint. Through the untiring efforts of the Exposition Preservation League, with which the City Engineer co-operated, if present plans are carried out, San Francisco is to have on the Exposition site a choice residential tract. This will be traversed by the Marina Boulevard and marked here and there with gems preserved from the Exposition, namely, the Column of Progress, the California Building, the Marina, Palace of Fine Arts, the Lagoon and the Yacht Harbor.

On the recommendation of this office, Pierce, Steiner, Francisco, Fillmore, Bay, North Point, Beach and Jefferson Streets were declared closed to permit the designing of a subdivision with roadways aligned in graceful curves, more in keeping with the natural attractions of the district than a gridiron street system.

The problems involved in planning the revised street arrangement were numerous. For example, the prevailing winds of the district could not be allowed to sweep along any main artery, and yet it was essential that certain remaining heritages of the Exposition be left visible as termini for properly framed vistas. The problem of proper distribution of traffic through the district was in turn complicated by the necessity of streets of changing direction while it was imperative that the maximum view frontage on the Golden Gate be developed.

The principal features of the plan which were finally adopted after more than a year's study were a north and south

axis centering on the Column of Progress and an east and west axis passing through the dome of the Fine Arts Building, both of which features will be recalled as ones that dominated their situations in the Exposition. At the eastern end of the east and west axis, centering on the Fire Arts dome, is a plaza approximately one acre in area from which a circular drive or boulevard distributes traffic to the secondary streets in the southern portion of the park. Courts have been planned at uniform intervals along the northern and eastern borders of the park in such a way as to create a succession of features along the two main boulevards while at the same time giving the maximum amount of view frontage looking on the Marina Park and the grounds of the Fine Arts Building. On the southern boundary two business centers have been created from each of which three arteries radiate to the main centers of the residence park.

It is proposed that the streets shall be paved and improved in the most modern manner and that all electroliers and other street ornaments shall be of special design. Public utilities such as gas, water and electric power mains will be installed underground. The plan incorporated some twenty odd plazas or parks at street intersections and includes eight or ten interior courts which will be devoted to recreational purposes.

On account of the reluctance of some of the property owners to enter into the scheme, the first section of the project only is now under process of resubdivision. This covers about one-half the area of the whole plot and requires the closure of about 870,00 square feet of existing streets laid out in the rectangular system and the opening of about 860,000 square feet of new avenues and boulevards.

Streets formerly traversing this area were uniformly sixty-eight feet nine inches wide, dividing the district into blocks two hundred seventy-five feet in width by four hundred twelve feet six inches in length. The new streets vary in width from one hundred feet for the Marina Boulevard with a roadway of fifty-one feet down to forty feet for the small intermediate streets.



Bay Shore Boulevard.

To Mark Daniels, Consulting Engineer, who had charge of the work of resubdividing this district under the supervision of the City Engineer, much credit is due for the results obtained.

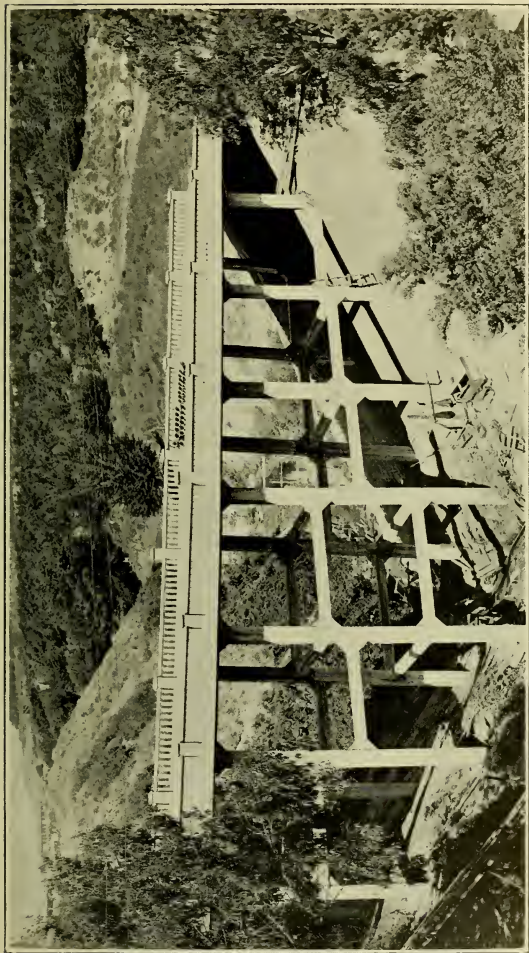
The Marina Boulevard passing along the northern boundary of the property is an important link in San Francisco's boulevard system, connecting the existing terminus at Fort Mason with a road to pass through the Presidio Military Reservation, a portion of which has already been constructed.

Skirting the northerly edge of the Marina Boulevard is the Belt Line Railway, of which the extension into the Presidio has been completed. The extension was urged by the Bureau of Engineering because of the military value of the track and the desirability of its being laid before construction of the boulevard was begun. As planned, the boulevard is free from railroad crossings and a screen of shrubbery will extend between railroad and the north sidewalk.

Due credit must be given to the Pacific Gas and Electric Company, and the Sierra and San Francisco Power Company for the generous manner in which they co-operated in exchanging lands to open this boulevard between Fort Mason and the Presidio.

Twice bids were called so that the \$30,000 appropriated in the last budget might be applied to the paving of the Marina Boulevard from Laguna to Scott Street, but in both instances the unit prices offered were too high and recommendations were made to reject the bids. Informal awards were made for the necessary fill along the boulevard. This fill was recently completed by day labor at one-third the cost of the amount set forth for that item in the formal proposals, thereby saving the City over \$2,000.

As the route of this boulevard crosses the made ground in Harbor View and the Presidio, where the Exposition Company has pumped from the Bay 1,300,000 and 360,000 cubic yards, respectively, thereby reclaiming 184 acres, observations were kept to determine when complete subsidence had taken place



Lobos Creek Viaduct, Camino del Mar.

so that street work, by undue settlement, would not be an economic loss to the City.

For the selection of Harbor View as the State Normal School site, the City Engineer actively co-operated, making three visits to Sacramento. Exhaustive investigations were made of the suitability of the existing California Building for a normal school and a report favorable on this location submitted to the State Legislature.

El Camino Del Mar:

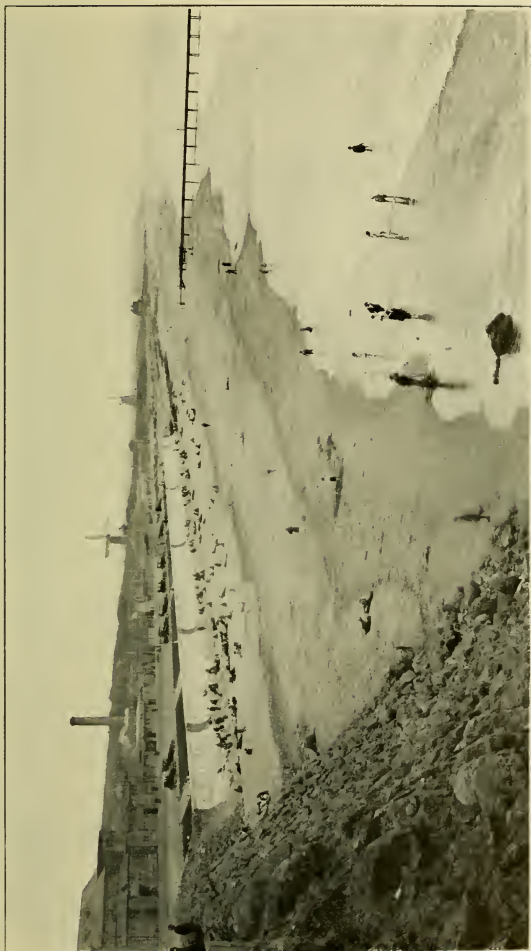
With the \$56,000 appropriated by the Panama Pacific Exposition Company, El Camino Del Mar, extending from Lobos Creek to Lincoln Park, over rights of way purchased by the City for \$30,000, has been constructed under direction of the City Engineer.

The Federal Government and City of San Francisco jointly constructed a reinforced concrete viaduct over Lobos Creek as a continuation of this boulevard, and a stretch of road will eventually be laid extending northerly therefrom to meet the existing driveways in the Presidio. Over three years ago this boulevard was started by the City, but it was impossible for some time to secure the prompt co-operation of the military authorities for the immediate completion of the project.

The Honorable Congressman Kahn, with co-operation of Senator Phelan, finally succeeded in having appropriated for the government's portion of this work, \$30,000. Contract for the viaduct over Lobos Creek was entered into in April, 1917, and is now 90% completed. An appropriation of \$5,000 was made in the City's Budget for 1917-18 to meet the cost of completing the westerly 99 feet from the center of the Creek.

From Point Lobos to Fort Miley, Forty-third Avenue has been paved recently thereby supplying one of the few remaining links between the Marina and the Esplanade.

The three boulevard units, Camino Del Mar, the Marina and Presidio drives, which stretch across the north shore of the City, will, when completed, besides possessing military



Ocean Beach Esplanade.

advantages afford many scenic attractions, enabling the pleasure seeker to obtain excellent continuous unobstructed views of the Bay, the Golden Gate and the Ocean.

Esplanade:

Few Cities in the United States can boast of a more inviting stretch of seashore than that which extends from the Cliff House three miles southerly to Sloat Boulevard.

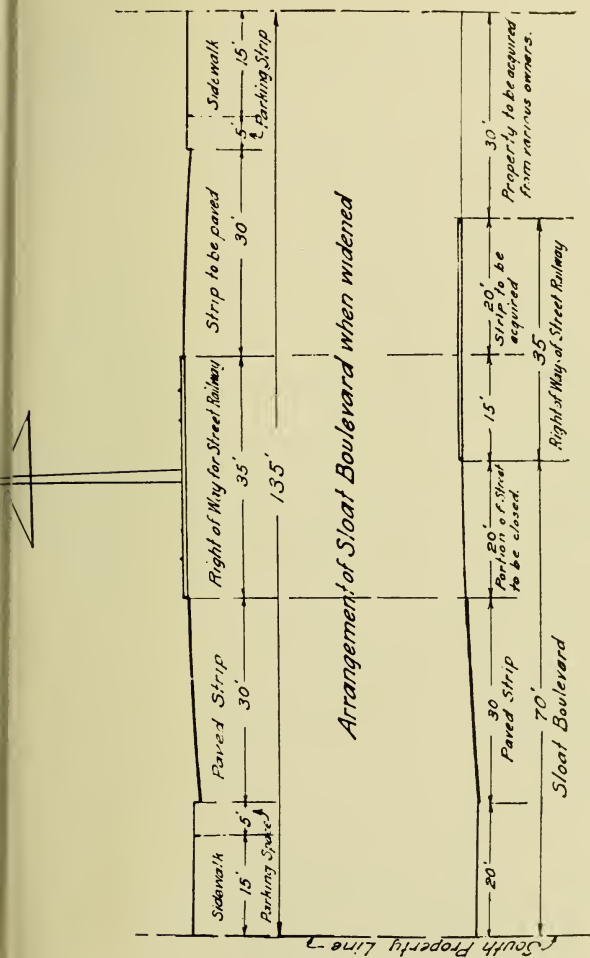
Plans have been made to provide proper shore protection for the entire distance against inroads of the sea and to pave and park the Great Highway permanently as befits the possibilities of this splendid driveway. Lack of sufficient appropriations has hampered these efforts, the net results to date being but a 670 foot stretch of reinforced concrete esplanade bulkhead to withstand the ocean's encroachments. A request for an appropriation of \$400,000 to extend the Esplanade to Lincoln Way was denied in the recent budget.

The finished section, constructed for the City under contract by J. D. Hannah, at a cost of \$80,000, has occasioned widespread commendation and interest any many inquiries have been received for detailed plans from communities with similar problems, especially New York and New Jersey cities. The marked improvement presented by the bleachers and parapet of this structure over the brush grown embankment replaced, should insure an early appropriation of the funds for the remaining portion.

New grades have been established for the Great Highway from Lincoln Way to Sloat Boulevard. This boulevard will have two roadways; the lower, on the easterly side will be 40 feet in width with two sidewalks, and will serve the fronting property and intersecting streets. The upper roadway on the ocean side will be 90 feet in width with an additional 25 foot walk. A terrace or parked slope will separate the two roadways.

Widening of Sloat Boulevard:

The original plans adopted by the City Engineer for Sloat Boulevard from the Great Highway to Junipero Serra



Present arrangement of Sloat Boulevard

Scale:- 1" = 20'

Boulevard, based upon future traffic needs, contemplated a 135 foot thoroughfare. This included a central space 35 feet wide to be occupied by the street railway, 30 feet of paved driveway on each side thereof, each adjoining 5 feet of parking and 15 feet of sidewalk. Present needs were accommodated with the south 30 foot paving strip, but the popularity of this drive with the ever increasing vehicular traffic caused negotiations to be hastened in order to complete the project as planned. Property owners along the north side of the present tracks have been prevailed upon to donate to the City sufficient frontage to make up the requisite 135 feet. The property was obtained by the City at no cost, contingent upon its starting the work by July, 1917. This has been done, the United Railroads having been persuaded to exchange its old right of way for the 35 foot central space, the City agreeing to pay the cost of removing and reconstructing the railway, the work of which is rapidly nearing completion. As soon as funds are available the northerly portion of the roadway will be improved providing for one way traffic on each driveway and minimizing the danger from collisions as well as greatly improving the appearance of the boulevard. The City Attorney's office is to be commended for earnest cooperation in this project.

Sky Line Boulevard:

The route of the proposed sky line boulevard, lying in San Francisco county, starts at the City Hall and traverses thoroughfares already complete, to the intersection of Sloat Boulevard and Forty-first Avenue. Thence it will extend in a southerly direction, encircling Lake Merced, and continuing southward to the County Line.

On September 25, 1916, the Board of Supervisors adopted the following resolution:

Whereas, There exists but one main highway from San Francisco along the peninsula into San Mateo and Santa Clara and Santa Cruz counties, which is rapidly becoming inadequate to meet traffic requirements, and the construction of an additional thoroughfare will soon become an imperative necessity, and

Whereas, It is possible to provide for the construction of a boulevard along the crest of the hills separating the ocean and bay and Santa Clara Valley and thus affording a route unparalleled for scenic grandeur as well as provide traffic accommodations for a large extent of territory; therefore

Resolved, That the City Engineer be requested to furnish the Board with the estimated cost of making a reconnaissance for a boulevard along the route stated; also

Resolved, That a copy of this resolution be transmitted to the Boards of Supervisors of San Mateo and Santa Clara and Santa Cruz Counties with a request that they meet in conference with His Honor the Mayor, City Engineer and Street Committee of this Board for the purpose of considering the project herein outlined.

In response to the request contained in the foregoing resolution, a meeting was held at Redwood City on December 9, 1916, which was attended by representatives of San Francisco, San Mateo, Santa Clara and Santa Cruz Counties.

The project outlined was endorsed by the representatives present and it was resolved that the legislature be requested to pass an act that would provide for the construction of the proposed highway by the counties jointly interested with such assistance as might be rendered in connection therewith by the State of California and the Federal Government.

On May 5, 1917, the Legislature having passed the necessary Act (Chapter 52, Statutes 1917) another meeting was held at San Jose, likewise attended by representatives of the same counties. Endorsement of the project was again given and it was directed that the City Engineer of San Francisco, the County Surveyors of the several counties, and Professor C. B. Wing of Stanford University, make a reconnaissance of the route of the proposed highway and furnish an estimate of the cost of the same.

Pursuant to said direction the several County Surveyors, to-wit: James V. Newman of San Mateo, Irving L. Ryder of Santa Clara, Lloyd Bowman of Santa Cruz, Professor C. B. Wing of Stanford University and H. W. Swanitz, assistant engineer, assigned to this work by the City Engineer of San Francisco, on May 10, 11 and 12, 1917, accompanied by W.

Lewis Clarke of the State Highway Commission, made a reconnaissance survey of the proposed route, beginning at San Francisco, following along the ridge between Bay and Ocean to the summit of Santa Cruz Highway, thence by Burrell Meyers to the head of Soquel Creek, thence by Corallitos Creek to Watsonville.

The route that I favor is from the City Hall, San Francisco, in a general southerly direction passing to the west of Merced Lake and thence down the peninsula, following east of San Andreas and Crystal Springs Lakes to the summit of the San Mateo-Half Moon Bay Road, thence due southerly along the Castle Rock ridge to the summit of the Los Gatos-Santa Cruz State Highway, and thence to Santa Cruz and Watsonville along the State and County Highways; or leaving the main ridge at Saratoga Summit and following the divide between the San Lorenzo and Pescadero Creeks along the State Park Road to the Ben Lomond ridge. From there the road would follow the general direction of the Empire grade to Santa Cruz and thence by County Highway to Watsonville, or, continuing along the crest of the main range from the summit of the Los Gatos-Santa Cruz Highway via Burrell Creek to the head waters of Soquel Creek, thence over the divide to Corralitos Creek and down same to Watsonville.

Sloat Boulevard Circle:

Anticipating the westward trend of development subsequent to the completion of the Twin Peaks Tunnel, the City Engineer devised a plan for co-ordinating at a common point of intersection the main thoroughfares south and west of Twin Peaks, named Junipero Serra and Sloat Boulevard, West Portal Avenue, connecting with the west portal of the Twin Peaks Tunnel, Portola Drive, which will connect with the Market Street Extension, St. Francis Boulevard, and the proposed entrance to the Spring Valley property. A satisfactory design has been worked out for the meeting of these boulevards to prevent congestion of automobiles and railway traffic

and still give a scheme in harmony with the high class residential districts developed and planned for the future.

This plan provides a large circular space suitably parked, within which will be the heavy network of tracks and track special work connecting the tunnel line with the existing Sloat Boulevard and the Junipero Serra Boulevard tracts, and a future rapid transit line down the peninsula. Two purposes, aside from the aesthetic, will be served by this circle. The railway crossings will be minimized and auto drivers will be compelled to slow down to make the curve in safety.

Already necessary property to the extent of nearly an acre has been acquired from the Westgate Park Company and Leopold Greene, for which voluntary assessments aggregating \$13,125 have been levied on adjacent property owners. Construction work will be started in the near future.

Grateful acknowledgement must be made for the unselfish efforts of Mr. Duncan McDuffie and his landscape engineers, Messrs. Olmstead Bros. of Boston, for needed assistance in this project.

One of the conditions of the contract between Fernando Nelson and the Residential Development Company, for the purchase of the west portal tract, was that the former should deed to the City sufficient property to give a strip 32 feet wide from the west portal of the Twin Peaks Tunnel to the circle above described. This proviso was made part of the contract by Mr. A. S. Baldwin, of the firm of Baldwin and Howell, the original owner of this land, in order that an avenue of egress from the tunnel westerly might be provided for the municipal railway. An extract from this agreement follows:

“I agree upon request of the City Engineer, M. M. O’Shaughnessy, to execute a good and sufficient deed to the City and County of San Francisco, of a strip of land not exceeding 32 feet in width for a right of way for railroad purposes, from the westerly portal of the Twin Peaks Tunnel to the westerly line of said 49.824 acre tract, it being understood that the City shall at its expense grade said strip of land to the level required for the operation of cars over the same, and that the City shall at its expense construct good and substantial concrete bulkheads along the northerly and southerly lines of said

strip wherever said right of way shall be in cut, and with the further understanding that unless changed by mutual agreement between the undersigned and said M. M. O'Shaughnessy, the plan prepared by John M. Punnett, dated March, 1916, attached hereto, will in all respects be carried out by me except that I reserve the right to change the width and location of any of the proposed streets."

Twin Peaks Boulevard:

The Twin Peaks tunnel provides only for rapid railway transit, as it would have been both dangerous and uneconomical to include an automobile roadway. Ample provision has therefore been made to enable autos to cut down time and distance between the down town districts and the districts lying west of the Twin Peaks Ridge, by the construction of modern boulevards along the grades between these two sections of the City.

Four years ago, to reach the westerly portion of the City the auto truck or pleasure car was compelled to avoid the ridge by taking a circuitous northerly route over Haight or Fell Streets and Lincoln Way to 19th Avenue, or a southerly route over Valencia or Mission Streets and Ocean Avenue. Today a thorofare over Twin Peaks affords one of the most scenic boulevards in the world.

Starting at the intersection of Sloat and Junipero Serra Boulevards, the Portola Drive, completed in 1915, extends easterly on an ascending grade, through the fast developing modern residential parks of St. Francis Wood on the south, and West Portal tract on the north.

At an expenditure of \$21,786.12, this driveway was extended last year along the route of the old Corbett Road to Twenty-fourth Street. This stretch, 4700 lineal feet in length, consists of a 20 foot paved strip of asphalt on concrete with 7½ foot shoulders, and is practically complete. As soon as possible it will be connected to the Market Street Extension, mentioned elsewhere in this report.

About 900 feet east of San Miguel Rancho, the Twin Peaks Boulevard connects with Corbett Road. The upper boulevard thence ascends in a northeasterly direction by easy

stages around the slopes of the Twin Peaks to an elevation of 830 feet, at which a figure eight loop encircles each of the peaks, the summits of which are about 80 feet higher. This work entailed an outlay of \$57,075.77. Since its completion in November, 1916, it has been most popular with local motorists and tourists. From no other eminence in San Francisco can such a varied and pleasing panorama of ocean, bay, mountain and metropolis be obtained.

The link of this road just east of the figure eight was completed in 1916 at a cost of \$26,907.97, and the adjoining stretch along Clarendon Avenue from St. Germain Avenue to Clayton Street, consisting of 1475 feet of pavement, 25 feet wide, and costing \$7,732, was finished in the early part of 1917. Topeka surface was used here because the maximum grade was as much as 13 per cent. Descent from Clarendon Avenue may be made on the north by Buena Vista Boulevard and on the south by Seventeenth Street.

NEW PROJECTS

Olympus Boulevard:

In a desire to provide a more direct approach to Twin Peaks Boulevard by light grades, a drive 60 feet wide has been planned, starting at Fourteenth Street opposite Alpine Street and winding by easy curves into Park Hill Avenue, Masonic Avenue, Pluto Street, Lower Terrace, Seventeenth Street and Clayton Street, to a connection with Clarendon Avenue.

Agreements for obtaining the lands required to widen existing streets and for new diagonal streets through present blocks have been entered into during the last two years. Lack of funds has been the cause of delaying actual construction. However, since the major portion of the cost of Olympus Boulevard is to be obtained by assessing the property owners benefitted, the near future should see its completion.

Market Street Extension:

Nearly thirty years ago, in the era of cable traction, surveys were made for the extension of Market Street out to the

Ocean Beach. This plan simply meant the prologation of the City's main artery on its present alignment, irrespective of grades. This early proposition was abandoned, and when the problem was recently considered, a contour avenue was decided on.

To co-ordinate with this plan, in the design of Twin Peaks Tunnel a flat top subway section was adopted for the first 1800 feet, because of proximity of the street surface. To provide for a surface extension of Market Street, fee simple title was secured for a strip 90 feet wide and the 1800 feet along the line of the tunnel in Eureka Valley from Seventeenth and Castro Streets to Eighteenth and Hattie Streets.

The tunnel is completed and already the crossings of Diamond, Collingwood, Douglass, Eureka, and Ord Streets, where they intersect the tunnel right of way, have been reconstructed to conform to the planned extension. Specifications are being prepared for the paving of the boulevard between these crossings so that in a few months the City's chief artery will have been extended up to Eighteenth and Ord Streets. Surveys and plans have been made for a 70 foot right of way from this point up to Twenty-fourth Street and Corbett Avenue, where connection will be made to the existing pavement of Corbett Avenue. The maximum grade over this route is 9 per cent.

At the unanimous request of property owners affected, plans for this project are well advanced and it is hoped at an early date to have it ready for appropriate action by the legislative authorities of the City.

San Bruno and Railroad Avenues:

The desirability has been recognized of relieving the congestion of traffic over Mission Street and the State Highway, the main southerly outlet into San Mateo County. The solution involved realigning, regrading and reconstructing the old San Bruno Road and Railroad Avenue to form the Bay Shore Boulevard. South of the San Francisco county line San Mateo has constructed an important link of this thorofare, connecting with the State Highway near Uncle Tom's Cabin.

Until recently the connection between San Bruno Avenue and Potrero Avenue was rough and unsightly. This has been corrected by extending Potrero Avenue from Twenty-fifth Street to intersect San Bruno Avenue, by widening the Ocean Shore Railroad Cut at Army Street and paving the entire distance. This involved over 20,000 cubic yards of excavation, at a cost of \$35,546.94. The regrading of Railroad Avenue to meet additional traffic requirements, was described in my last annual report.

Hunters Point Road:

As a war measure, last year the Federal Government appointed a committee to investigate and report on the suitability of various sites on the Pacific Coast for the location of a permanent naval base. Familiar with the unquestioned natural advantages of Hunters Point for the purpose, the City administration actively advocated its selection. Reports were prepared which showed that there is a water depth of 65 feet at the point and a deep water channel thence to the Ocean, whereas the other Bay sites considered have less than 20 foot depth, which is being decreased because of deposits of sediment from the San Joaquin and Sacramento Rivers. Assurances were given the Naval authorities that proper road facilities would shortly be constructed to make the site more accessible. While no official decision on the choice of a base has been published, it is understood that the Hunters Point site is favorably considered.

To reach Hunters Point, and to provide for existing and future industries in this section, special endeavor has been directed toward the early completion of an 80 foot street with a 60 foot roadway, commencing at Railroad Avenue along Evans to Ingalls, thence diagonally through land acquired from the Water Front Land Company to Hawes near Hudson Street, thence along Hawes from Hudson to Innes, thence along Innes from Hawes to Donohue, thence along Donohue, Innes to Galvez, thence along Galvez, Donohue to Coleman, thence through City property diagonally from Coleman and Galvez to Boalt Street and Fairfax Avenue, thence along Fairfax

from Alvord to Boalt and along Alvord, Evans to Fairfax, to the existing dry dock of the Union Iron Works on this point, a distance of $2\frac{1}{4}$ miles. This work involves 91,427 cubic yards of excavation and 101,876 cubic yards of fill, besides curbs, sewers and 637,669 square feet of pavement with 6 inch concrete base and 2 inch asphalt wearing surface. Two acres of property are to be acquired.

The cost will be about \$225,000, part to be borne by the Union Iron Works and the City and fronting property owners to pay the remainder. About three-fourths of the entire length is under contract. Nearly 90 per cent of the necessary property has been acquired and as soon as the remaining portion has been deeded to the City, contracts will be awarded for the remaining construction.

The completion of this project will have the effect of opening up two miles of deep water frontage heretofore inaccessible.

Telegraph Hill Boulevard:

By proper landscape treatment Telegraph Hill can be made an attractive eminence instead of a quarry scarred obstruction to traffic. The first requirement is a suitable avenue of approach to the summit. Four schemes have been evolved, each of which contemplates a roadway 24 feet wide and a 6 foot sidewalk with a protecting railing. The initial point of the various schemes is as follows:

(1) Northeast corner Kearny and Broadway; (2) Northeast corner Montgomery and Broadway; (3) Just west of Washington Irving School in Broadway; (4) Northeast corner of Sansome and Vallejo Streets.

The terminal at the upper end, Lombard and Sansome Streets, is common to all plans. The property in the last two blocks along and adjacent to the boulevard is to be retained for park area as an addition to Pioneer Park. City property in the vicinity will be utilized where practicable. Any scheme adopted embraces a reinforced concrete viaduct about 300 feet

long between Lombard and Greenwich Streets. Schemes No. 3 and 4 include an additional viaduct across Green Street.

Maximum grade, length and estimated cost of construction of the four schemes is as follows:

Scheme	Length in Feet	Maximum Grade	Est. Cost of Const.
1	2800	8.5%	\$154,000
2	2500	10%	140,000
3	2450	10%	142,000
4	2200	8.2%	135,000

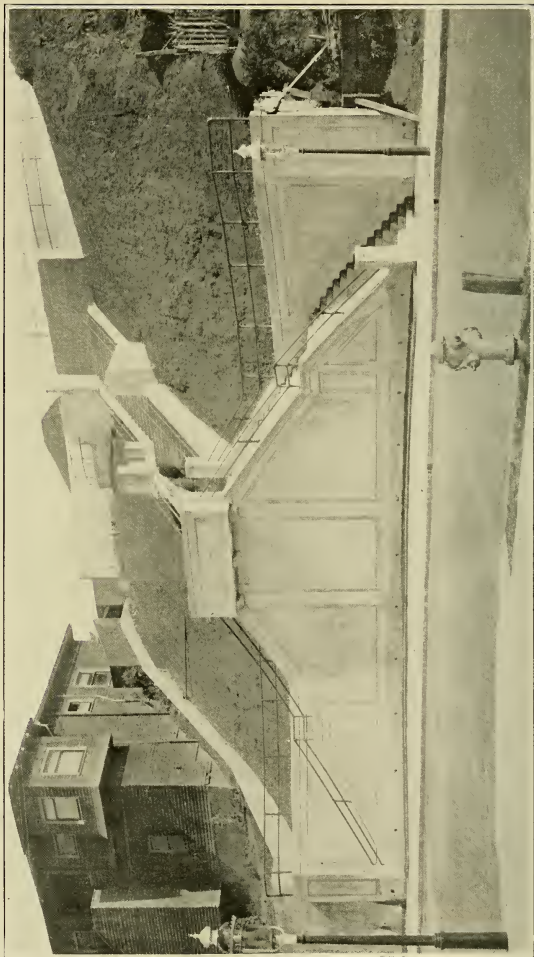
Regrades:

Most of the area of the City and County of San Francisco has been subdivided on the right angle block system, with no thought whatever for the contour of the ground or steepness of the grades, many of which are as high as 40 per cent. In altering such grades, existing improvements must be considered, many lots having already been built upon, and each property owner desirous that the grade fit these improvements.

The modern subdivision with its contour streets and easy grades is eliminating this evil. On the ungraded streets which are too steep for vehicular travel, it is found desirable to park the majority of the street and construct easy stairways. An example of such treatment is on Day Street between Castro and Diamond Streets. Greenwich Street between Kearny Street and Grant Avenue, which has never been graded, is built upon both sides with many permanent structures. Special treatment, such as is shown on attached diagram is necessary to obviate raising or lowering every building on the block.

Liberty Street between Church and Noe Streets and Sanchez Street between 20th and 21st Streets are similar to those above mentioned inasmuch as they are ungraded, built upon, and have very heavy cross warps.

On these streets it is found advantageous to design an upper and lower roadway with parking space and walls be-



Regrade of Cumberland Street, Looking Southerly from 19th Street.

tween, and to open two new streets so that vehicles can travel in a southerly and westerly direction to Noe Valley.

Money for the acquisition of the property necessary for the above projects has been included in the 1917-1918 budget and the City Attorney has commenced action to acquire it.

In the past year grades have been changed, established and investigated as follows:

Grade changes—333 blocks, 159 crossings.....	24 miles
Grade establishments—109 blocks, 50 crossings.....	6½ miles
Investigations—138 blocks, 55 crossings.....	10 miles
Total	40½ miles

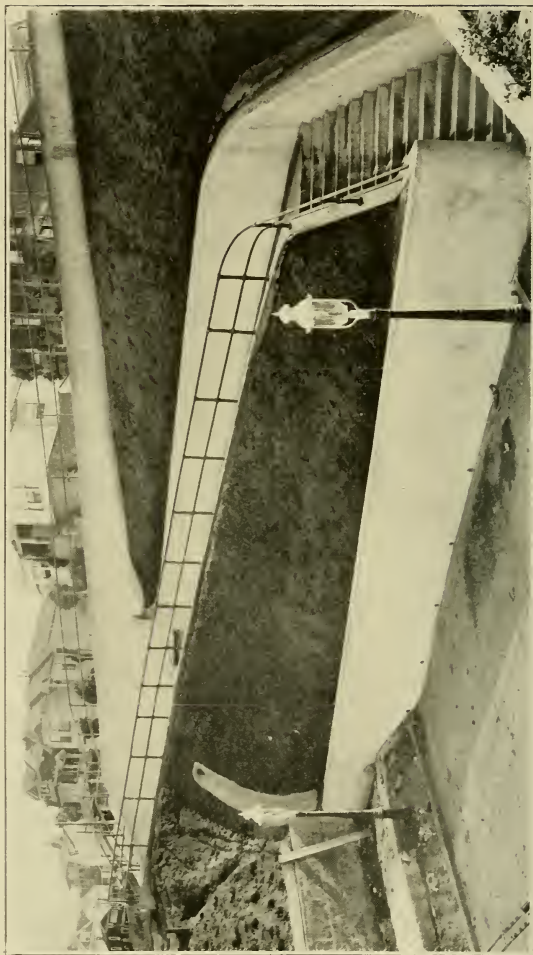
A number of other streets where special treatment in grades have been made and which will be improved in the near future, are:

Carolina St. between Twenty-second and Twenty-third Sts.
 Lyon St. between Broadway and Vallejo Sts.
 Alvarado St. between Castro and Diamond Sts.
 Missouri St. between Twentieth and Twenty-second Sts.
 Douglass St. between Twentieth and Twenty-first Sts.

The area lying south of Howard Street and east of Third Street comprising about twenty city blocks on an elevation known as Rincon Hill, in former days one of the choice resident districts of San Francisco; but this hill formed a natural barrier to the main lines of traffic between a mile of waterfront docks and freight terminals and the area dependent upon them, comprising the general industrial district and the business center of the City. Its proximity to the waterfront and the railroads is the cause of the development of this section from a residence district to an industrial and warehouse center.

The Chamber of Commerce made some preliminary studies of Rincon Hill in 1912 with a view to suggesting a scheme for its regrading.

This office has made a comprehensive study of the problem and evolved several improvements on the original schemes presented.



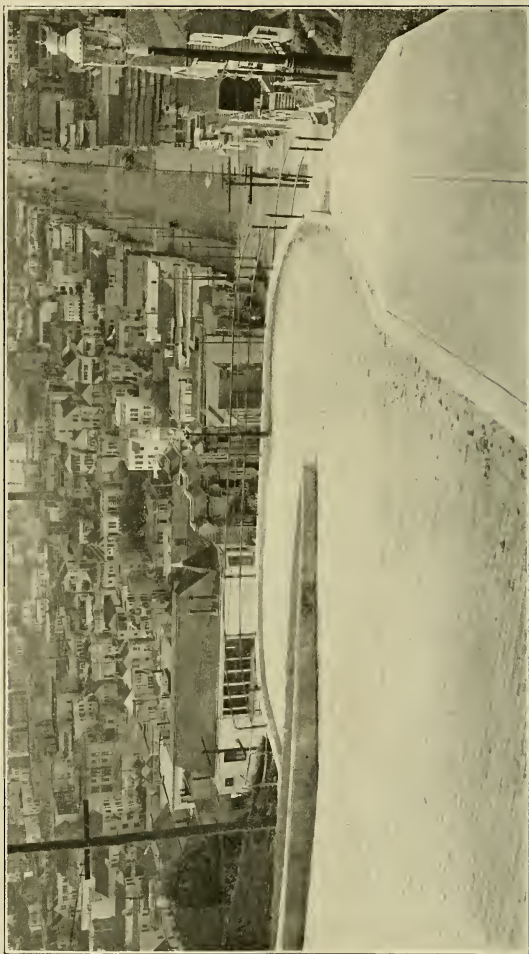
Regrade of Cumberland Street, Looking West from Sanchez Street.

It was found that with a reasonable amount of excavation gradients could be established having a maximum of 2 per cent for north and south streets and $4\frac{1}{2}$ per cent for east and west streets. With these street grades established, every piece of property east of Second Street and south of Folsom Street could be reached by a projected system of railroad spur tracks terminating in the main Belt Railroad system. Modern motor trucks could easily make the maximum grades on the east and west streets. The hill would no longer be a barrier to heavy traffic and about 46 acres of land with practically no earning power could become a potential income bearing property worth from two to five times its present value.

About 90 per cent of the existing improvements upon the property in this district are wooden structures, many of them obsolete, and the owners would welcome an opportunity to replace them with a more substantial type of building. The present condition of the property makes it very difficult for the owners to negotiate loans for any improvements. It was found that the cost of improving the streets could not be sustained by the adjoining property. Close study of the problem shows that the owners of this property would not by any means be the sole beneficiaries by improvements contemplated, but that a very large metropolitan area would be materially benefited. To effect maximum economy it is desirable to grade and make all of the improvements in this area, as one project centrally controlled. Before this can be done, certain changes in the assessment laws for local improvements must be enacted.

The following is a tabular resume of the principal elements in the Rincon Hill regrade project:

Estimated cost of street work including 1:1 slopes.....	\$1,500,000
Estimated cost of grading private property and restoring improvements	\$2,500,000
Present average assessed value private property (60% of full value).....	\$.76 sq. ft.
Full value on same basis according to 1916 assessment.....	\$1.25 sq. ft.
Average estimated value after improvements.....	\$2.50 sq. ft.
Permissible to spend for improvement to private prop.....	\$1 25 sq. ft.



Regrade of Cumberland Street, Looking North to 19th Street.

Area of proposed reduced district.....	2,000,000 sq. ft. 46 acres
No. parcels of property involved in regrade.....	277 parcels
No. city blocks involved in regrade.....	13 city blocks
Estimated cost of grading private property and restoring improvements not incl. 1:1 slopes.....	\$1.25 sq. ft.
Total yardage of materials to be removed.....	3,386,000 yds.
Time required for removing hill estimated at.....	3-4 years

Bernal Cut:

The bulk of the materials used for street and home improvements in new subdivisions beyond the Twin Peaks Ridge was conveyed via Mission Street and Ocean Avenue or over Fell Street and Lincoln Way. The grades and length of the former route added so much to the cost per ten mile that the proposed Bernal Cut could have been built for the saving it would have had effected to date.

One of the conditons made part of the agreement for the Southern Pacific Company's new franchise at Third and Townsend Streets was that the City should be given a right of way through the existing Bernal railway cut from Randall Street to San Jose Avenue, the Railway Company to do the necessary grading to accommodate the paved roadway.

With the rapid growth of our Municipal Railway System, the extension through this cut of the Church Street Line from 30th Street to supply needed traffic facilities to the Sunnyside and Ocean View Districts, was planned, and in order to provide for the street railway, as well as vehicular and pedestrian traffic, steps have been taken to acquire a wider roadway through the cut than that provided in the original agreement. Surveys and plans for this improvement are complete and necessary lands are being acquired.

This work involves the extension of Dolores Street to the existing Southern Pacific right of way at Randall Street, the removal of 232,000 cubic yards of excavation and placing 95,500 cubic yards of fill, the removing and reconstructing of the Southern Pacific tracks to the west side of the widened cut, the paving of a 42 foot roadway and construction of an 8 foot sidewalk with necessary retaining walls on the

east side of cut throughout the 4,450 feet of length. The cost will be approximately \$650,000, exclusive of the grading to be done by the Railroad Company.

Cumberland Street, Noe to Sanchez Street:

The regrade of Cumberland Street between Noe and Sanchez Streets and Sanchez Street between 19th and 20th Streets has been completed. Persistent efforts to reconcile the diversified opinions of the people of this district and obtain their agreement to the most logical plan, finally were successful.

Existing street improvements leading to this section, the abrupt nature of its topography and the fact that fronting owners had proceeded with their home building with an utter disregard for any grade plan, injected complications into this problem, requiring the application of some engineering ingenuity for solution.

Sanchez Street at 19th Street was graded and paved while 50 feet south the ground was 16.5 feet higher. Cumberland Street at Sanchez Street was graded and paved while 20 feet west the ground was 31 feet higher. Sanchez Street at Cumberland Street was improved with an elevation at the northerly line of 198.83 and at the south line of 209.17 whence the ground rose sharply to an elevation of 240 feet. Twentieth Street at Sanchez was an improved street having an elevation of 240 feet the east side of Sanchez Street conforming to official grade, while the west side was 25 feet higher.

The only inlet adaptable to changes that would permit of vehicular traffic was via Twentieth Street. This will also serve the district south of Twentieth Street between Church and Noe Streets. By a system of retaining walls and stairways, pedestrians may reach this region at Sanchez and Nineteenth Streets, Cumberland and Noe and Cumberland and Sanchez Streets. The general street design of roadways and walks in the same plane was precluded here, the difference in elevation between houses on opposite sides of the street being from 7 feet to 19 feet. To keep at a minimum

the height of retaining walls, at the property line on the high side and still not leave the homes on the low side in a hollow, the space between curbs was designed with elevated or depressed sidewalks and terraces. These terraces vary from level parking spaces to sloped surfaces having a pitch of 10 feet in a width of 11 feet and 13 feet, according to ground conditions. As planned, the majority of retaining walls did not exceed 6 feet in height. Three were constructed at a maximum height of 12 feet. In some instances where the fronts of the houses were back of the property line, the terraces were extended into the property thereby doing away with necessity of a wall. A 2½-foot cross warp in the roadway, was resorted to to cut down heights of walls.

Sanchez Street from Twentieth to Cumberland Street is paved with 2 inches of asphalt on a 6 inch concrete base descending on a 5.3 per cent grade. The crossings of Sanchez and Cumberland Streets is similarly paved. From the north line of Cumberland to 89 feet northerly, the grade of Sanchez Street is 16.6 per cent and thence to Nineteenth Street it is 28 per cent except the parking space and wall where the grade is lessened to permit vehicles to turn. Hillside brick pavement was used where grades were sufficient to warrant the increased cost.

On Cumberland Street west of Sanchez Street a 9.5 per cent grade obtains for 155 feet, a 4 per cent grade for the next 100 feet and a 15 per cent grade for the remainder to Noe Street, except around the island park at Noe Street where the grade is reduced to allow traffic to turn.

Concrete in walls and stairs was a 1-2-4 mix delivered from mixer to forms by gravity chutes. Six inch tile drains imbedded in broken rock were placed back of all walls and concreted to weep-holes at proper intervals.

Galvanized iron railings are placed on walls where necessary. Special fittings had to be cast for all this work on account of the many curves and breaks in grade. Hardly any two fittings were alike.

Excavation was performed by a $\frac{3}{4}$ cubic yard steam shovel except at Sanchez and Nineteenth Streets where the steep grade made the use of the shovel dangerous. Here a trap was erected and 4-horse Fresnoes scraped the material into chutes which led into the trap, whence it was loaded into motor trucks. Over 20,000 cubic yards loose measurement was handled in this manner.

Now that this section has been made accessible and that these streets present an inviting appearance, the wonderful view to be obtained from this height, the ideal climatic conditions existing there, and the proximity of the Church Street Line of the Municipal Railway System, will all be potent factors in inducing people to locate. Property enhanced substantially beyond its original value since the improvement was assured.

Leavenworth Street and Chestnut Street:

Francisco Street between Hyde and Leavenworth Streets at an elevation of approximately 130 feet before the recent improvement of Leavenworth Street between Chestnut and Francisco Streets, has been practically inaccessible. The only approach thereto, over Hyde Street between Chestnut and Bay Streets was on a 20.5 per cent grade with a very dilapidated cobblestone pavement.

A few years ago new grades were established to provide a convenient approach to this district. The first unit of this improvement was completed in December, 1914. This consisted in part of a retaining wall swinging from near the middle of the south line of the crossing of Francisco and Leavenworth Streets to the north curb at the west line and a stairway on the northeast face of the wall leading from the upper to the lower levels of the crossing. As then finished, ready ingress and egress was afforded pedestrians, but a second unit of this work had to be installed to accommodate vehicles. This consisted of the continuation of the existing retaining wall southerly in Leavenworth Street parallel to the property lines for a distance of 187.5 feet dividing the street into two levels.

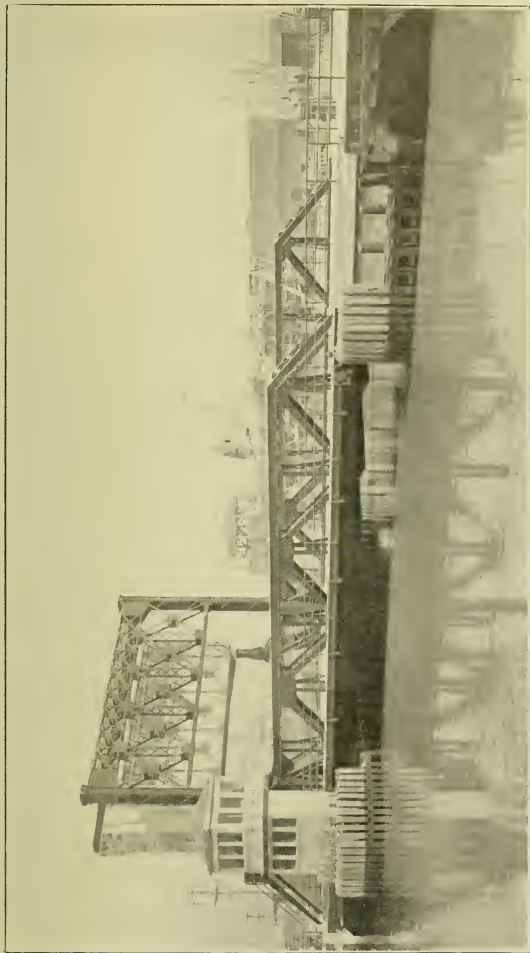
The new grade of upper Leavenworth Street follows closely the old San Francisco Road which in early days led from the heart of town to Black Point.

When completed the 68.37 feet width of Leavenworth Street will be divided into a 10 foot walk on the east and a 6 foot walk on the west side with roadway of 52.37 feet wide extending from Chestnut Street northerly to the end of the retaining wall where it divides into an upper drive of 17.5 feet wide and a lower drive of 32 feet wide. The grade from Chestnut Street to the dividing wall and 50 feet northerly on the lower portion of the street descends at 15.9 per cent and then at 6.8 per cent to the crossing of Francisco Street. The upper roadway ascends northerly along the east face of the wall on a 3.4 per cent grade. The street is paved with 2½ inches of asphalt surface on a 6 inch concrete base except on the 15.9 per cent grade where hillside brick are laid on a 1½ inch sand cushion on a 4 inch concrete base.

The heavy portion of the excavation, 5,800 cubic yards was done by steam shovel. To insure against undue settlement in the fill back of the wall, special precautions were taken in tamping. The fill, placed by wheelbarrows, was water tamped, the weep holes in the wall having been temporarily plugged to hold the water and all pulled simultaneously to give a uniform settlement. The subgrade was rolled with 5-ton motor trucks empty and then loaded.

The wall of reinforced concrete of the cantilever type surmounted with a 4.25 foot parapet is 31.25 feet high at one end and 5.75 feet at the other. Exclusive of the base and parapet, it is 12 inches thick at top and batters 7 inches to 5 feet of depth giving a maximum base thickness of 3.86 feet at the highest section.

A 20 inch high pressure pipe, one of the main feeds from the Fort Mason Pumping Station which has been constructed in tunnel, was uncovered along the east edge of the toe of the wall.



Fourth Street Bascule Bridge—Closed.

BRIDGES

Third Street Bridge:

The Third Street Bridge was rewired and a new submarine cable was installed under contract awarded to the Butte Engineering & Electric Company on August 24, 1916. The work was completed and accepted on June 25, 1917, and cost \$3,874.

The laurel wood floor surface placed two years ago is making a record for service, being still in very good condition. Ordinary pine flooring formerly used had to be replaced three times during each year.

The south abutment, disturbed at the time of the earthquake in 1906, continues to move northward at a decreasing rate, being about one inch during the last 12 months, as against two inches per year prior to that time. The movement this year has been taken up in the structure with minor alterations and adjustments made possible by the work done last year. Despite the opening of the Fourth Street Bridge traffic on Third Street Bridge continues heavy. During rush hours eighty street cars and over two hundred vehicles per hour, cross the structure.

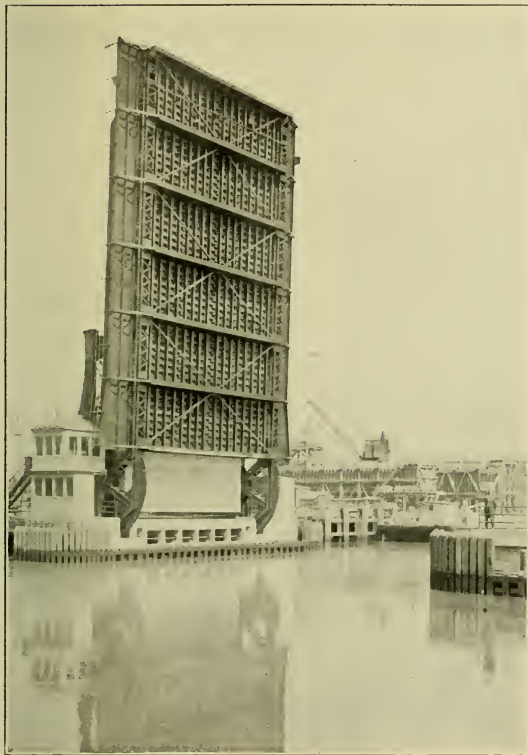
Fourth Street Bridge:

On June 25, 1915, the Thomson Bridge Company was awarded the contract for removing the old swing drawbridge and for constructing a modern Strauss Trunnion Bascule drawbridge at Fourth Street, crossing the channel.

The foundation for this bridge was designed in this office and the superstructure was designed by Mr. J. B. Strauss of Chicago, patentee of this type of bridge.

The bridge proper is a single leaf, through span of 94 feet, counterweighted on the north side with a 700 ton overhead concrete weight spanning the roadway.

The bridge roadway is forty feet wide and is paved with creosoted wood blocks. Provision has been made for the installation of street car tracks should they be required at



Fourth Street Bascule Bridge—Open.

any time. There are two 6-foot sidewalks on the outer side of the trusses for pedestrians.

Operating power is furnished by electric motors housed on the north side. The operator's house is over the west motor housing and commands a clear view. Opening to the full vertical position can be effected in approximately one

minute after giving the warning alarms. A clear waterway of 75 feet for the passage of vessels is obtained with the structure raised. The channel was dredged to elevation minus 35 feet, City base, which enables vessels of 20 foot draft and fifty foot beam to pass the opening safely.

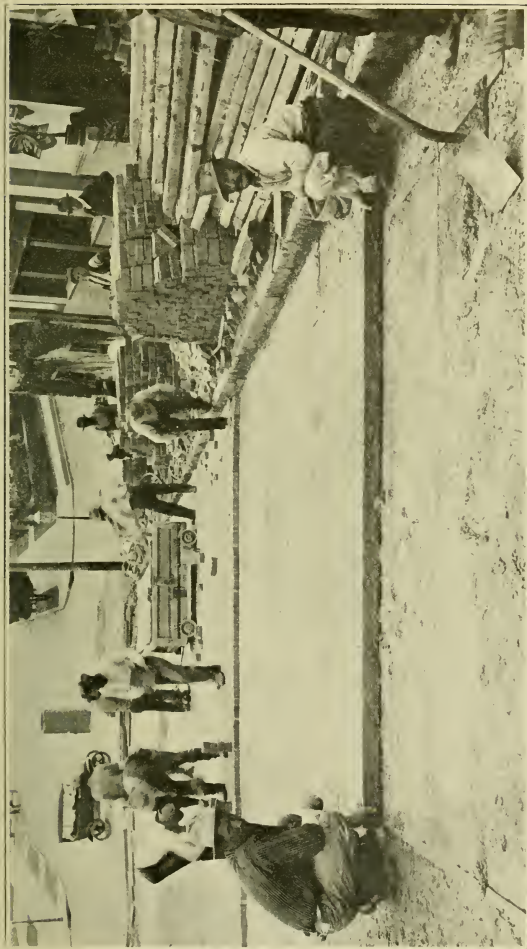
This improvement cost \$89,672.09 and was finally accepted on May 23, 1917.

STREET PAVEMENTS

More permanent pavements have been constructed within the past fiscal year than in any other year since the memorable fire of 1906.

A new type of permanent pavement adapted to light traffic and residential streets was introduced here, namely, the so-called vertical fibre vitrified brick, a monolithic type of pavement. This has been in use for the last three years in the middle west and has given satisfactory results. Its chief advantages over the older vitrified brick pavement are its comparative cheapness and ease of construction. A service test of at least ten years will be required, however, before its permanency can be established beyond question. Should this pavement prove entirely satisfactory and be permanently adopted, its selection will affect a saving of from 15 per cent to 20 per cent over the old standard brick pavement.

Another advance in pavement construction has been made in the adoption of "Topeka," a semi-nonskid sheet asphalt pavement. This pavement is particularly suitable to streets that have a gradient in excess of that which ordinary sheet asphalt can be used, but on which a comparatively smooth pavement is required. In general, on residential streets of medium grade Topeka surface can be used in place of the ordinary asphalt pavement. With the enormous urban automobile traffic of the present time, a pavement having pronounced nonskid properties becomes a necessity.

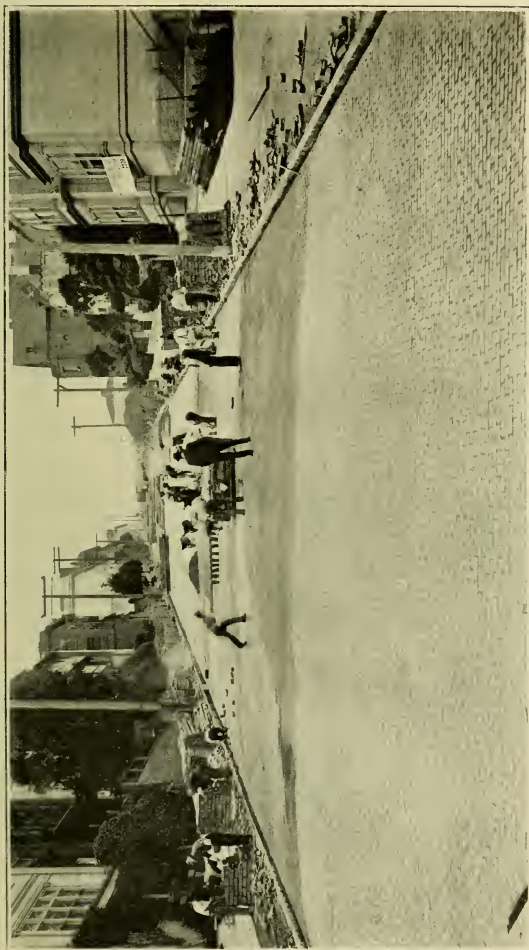


Laying Monolithic Brick Pavement.

Topeka surface has been used extensively in the construction of streets in Westwood Park and other recently developed residential tracts. It has also been used on the northerly end of the Twin Peaks Boulevard, and on the first unit of the Market Street extension adjoining the east portal of the Twin Peaks Tunnel, and probably will be used upon the entire boulevard. The fact that this pavement has stood up on the State Highway in San Mateo County for four years under the tremendous pounding of Sunday traffic amounting to 15,000 machines of all types, is proof that it will wear well in San Francisco under less severe conditions. Our experience with asphalt has proven that the successful street pavement of the future will be of less thickness than formerly and will possess greater nonskid properties, 90 per cent of the traffic now being rubber tired.

One of the greatest difficulties encountered in the planning of street pavements is that of procuring proper surface drainage, with the improvements and grades often permanently established. Especially is this the case on thoroughfares having nearly a flat grade. The addition of too many catch-basins is both costly as well as unsightly. It was for this reason that this office recommended the adoption of vitrified brick gutters in connection with asphalt pavements on such streets, it being possible to construct this type of gutter with a flatter gradient and an individual transverse slope, thereby preserving a uniform cross-section on the main moving-traffic portion of the roadway.

Within the last fiscal year many special projects in the way of street improvement had to be handled by this department and, working plans for the Contractor prepared. To expedite the work of planning some of the more difficult of these, paper forms were made to scale showing the proper crowns and section. These were put in skeleton form and modified when necessary. Plaster of Paris was poured over modeling clay rough shaped to the finished contour and the whole finally smoothed down to the finished grade. This was found to be an excellent way of visualizing the improve-



Section of Completed Monolithic Brick Pavement.

ment and brought out forcibly small irregularities in design that might otherwise have been overlooked.

Nearly all of the many miles of track reconstruction handled by the United Railroads within the year, and all street reconstruction handled by the Street Repair Department was constructed on the grades worked out by this office.

AMOUNT AND COST OF STREET WORK—PRIVATE

Fiscal Year ending June 30, 1917.

	Quantity Sq. Yds.	Cost
Asphalt (6" Concrete Base):		
W. S. 1½" Binder 2".....	1,175.11	\$ 2,644.00
W. S. 2 "	223,195.66	454,757.27
W. S. 2½"		
W. S. 1 " Binder 1½".....	373.37	873.68
Bituminous Rock (6" Concrete Base):		
W. S. 2"	17,524.32	38,423.35
Basalt Blocks:		
Gravel and asphalt filler on sand.....	14.00	45.36
Gravel filler (6" concrete base).....	349.28	1,336.27
Cement filler (6" concrete base).....	3,506.81	8,801.94
Vitrified Brick:		
Kiln marked or hillside.....	4,101.47	14,355.75
Asphalt with Basalt Block Strip:		
Asphalt W. S. 2".....	1,063.22	4,246.92
B. B. with gravel filler.....	490.00	1,848.50
B. B. with gravel and asphalt filler.....	305.00	1,193.36
Asphalt with Vitrified Brick Strip:		
Asphalt W. S. 2".....	81,366.54	169,868.13
Brick, kiln marked or hillside.....	29,902.96	103,234.74
Broken rock	2,664.66	1,560.00
Cobbles	480.72	1,081.62
Total	366,513.12	\$804,270.89
Curbs:		
Granite, new—lin. ft.	14,582.70	17,303.38
Granite, reset	1,263.91	226.58
Concrete	139,958.90	105,412.02
Gutters:		
Basalt blocks—sq. yds.	325.28	1,228.49
Walks:		
Artificial stone	9,474.85	9,122.64
Grading:		
Cut	95,426.00	53,439.50
Fill	45,292.00	23,552.03
Total	140,718.00	\$ 76,991.53

AMOUNT AND COST OF STREET WORK—PRIVATE—Continued

	Lin. Ft. & No.	Cost
I. S. P. 6" Diameter:		
Side Sewer	732.00	\$ 378.00
I. S. P. 8" Diameter:		
Pipe	14,725.75	31,187.80
Y branches	892.00	949.41
I. S. P. 12" Diameter:		
Pipe	6,543.20	15,694.38
Y branches	355.00	432.50
I. S. P. 15" Diameter:		
Pipe	1,271.15	3,238.90
Y branches	55.00	106.00
I. S. P. 18" Diameter:		
Pipe	1,752.53	4,621.00
Y branches	92.00	129.00
I. S. P. 21" Diameter:		
Pipe	593.00	2,316.00
Y branches	36.00	36.00
Totals	25,617.63	\$ 57,436.08
	1,430.00	1,652.91
Manholes:		
New	154	14,195.98
Catchbasins:		
New	242	14,280.67
Reset	6	55.00
Storm water inlet.....	3	150.00
I. S. P. 10" Diameter:		
Culvert	7,706	22,682.29
I. S. P. 24" Diameter:		
Pipe	275.00	1,375.00
Y branches	18.00	36.00

AMOUNT AND COST OF STREET WORK—PUBLIC

Fiscal Year ending June 30, 1917.

	Quantity Sq. Yds.	Cost
Asphalt (6" Concrete Base):		
W. S. 2"	169,373.77	\$279,818.54
W. S. 1" Binder 1½"	2,043.55	2,942.72
Basalt Block (on sand):		
Gravel filler	4,529.68	14,252.08
Gravel and asphalt filler	3,073.55	10,511.56
Basalt Block (6" Concrete Base):		
Gravel filler	95.79	379.33
Cement filler	806.20	2,829.78
Vitrified Brick:		
Kiln marked or hillside	4,576.78	14,611.75
Asphalt with Basalt Block Strip:		
Asphalt W. S. 2"	3,452.50	6,069.30
B. B. with gravel filler	1,724.72	5,713.68
Asphalt with Vitrified Brick Strip:		
Asphalt W. S. 2"	57,336.45	97,736.01
Brick, kiln marked or hillside	18,773.31	54,087.05
Broken rock	23,579.39	12,217.63
Cobbles	1,036.54	1,976.58
Broken rock walks	9,608.69	1,567.55
Total	300,010.92	\$504,722.56
Curbs:		
Granite, new	26,237.65	27,083.13
Granite, reset	377.62	136.69
Granite, redressed and reset	70.80	10.62
Concrete	89,765.42	55,980.40
Redwood	7,056.70	1,361.71
Gutters:		
Basalt blocks	9,370.21	3,546.62
Concrete	302.00	45.43
Artificial Stone Walks	32,245.77	33,533.54
Grading:		
Cut	192,154.44	90,602.15
Fill	123,824.50	38,630.94

AMOUNT AND COST OF STREET WORK—PUBLIC—Continued

	Quantity Lin. Ft. & No.	Cost
I. S. P. 6" Diameter:		
Side sewer	6,073.00	\$ 2,790.67
I. S. P. 8" Diameter:		
Pipe	16,633.51	23,626.18
Y branches	1,061.00	794.20
I. S. P. 12" Diameter:		
Pipe	10,746.68	16,173.46
Y branches	439.00	608.05
I. S. P. 15" Diameter:		
Pipe	1,984.32	3,244.17
Y branches	78.00	346.40
I. S. P. 18" Diameter:		
Pipe	3,284.34	6,719.81
Y branches	134.00	183.00
I. S. P. 21" Diameter:		
Pipe	307.00	531.60
Y branches	18.00	27.00
Totals	39,028.85	\$ 53,085.89
	1,730.00	1,958.65
Manholes:		
New	151	8,332.50
Rebuilt	1	200.00
Catchbasins:		
New	296	16,653.50
Reset	9	205.00
I. S. P. 10" Diameter:		
Culvert	8,529	7,896.77

AMOUNT AND COST OF STREET WORK—CITY PAY

Fiscal Year ending June 30, 1917.

	Quantity Sq. Yds.	Cost
Asphalt (6" Concrete Base):		
W. S. 2"	237.00	\$ 430.55
W. S. 1" Binder 1½"	56,517.66	66,594.68
Basalt Block:		
Header Blocks	850.60	763.27
Curbs:		
Granite, new	2,096.55	1,677.24
Concrete	203.00	152.25
Gutters:		
Concrete	33.44	45.22
Artificial Stone Walks.....	1,061.00	943.14
Grading:		
Cut	107,069.00	38,456.43
	Lin. Ft. & No.	Cost
I. S. P. 6" Diameter:		
Drain pipe	1,000	450.00
I. S. P. 12" Diameter:		
Pipe imbedded in concrete.....	331	496.50
I. S. P. 12" Diameter:		
Pipe—lin. ft.	365	620.00
Y branches	10	5.00
Manholes:		
New	3	150.00
Catchbasins:		
New	12	566.00
I. S. P. 10" Diameter:		
Culvert—lin. ft.	320	274.45

CONTRACT EXPENDITURES EXCLUSIVE OF HETCH HETCHY WA

Contract	Contractor
South Bay View District	Tibbitts Pac. Const. Co.....
Oakdale Avenue Sewer.....	Karl Ehrhart
Sloat Boulevard, 24th to 31st Ave.....	Tibbitts Pac. Const. Co.....
Railroad Ave., San Bruno to Ingerson.....	Tibbitts Pac. Const. Co.....
Somerset, Wayland to Felton and Felton, Somerset to University.....	Tibbitts Pac. Const. Co.....
Glen Park Sewer, Burnside to Chenery.....	Karl Ehrhart
LaPlaya and Great Highway, Lincoln Way to Noriega.....	Clinton Const. Co.....
Concrete Sump for Commercial St. Sewer Pumping Station.....	Bos & O'Brien.....
Orizaba and Stanley Sts.....	D. L. Bienfield.....
Outfall for Jackson St. Sewer at Pier No. 3.....	Contra Costa Const. Co.....
Dredging around Outfall of Pierce St. Sewer.....	Healy-Tibbitts Const. Co.....
7th Ave. Extended and Dewey Boulevard Sewer.....	D. L. Bienfield.....
Twin Peaks Tunnel.....	R. C. Storrie & Co.....
Stockton Street Tunnel.....	Jacobsen & Bade.....
Third St. Bridge, Alteration of South Leaf.....	Thomson Bridge Co.....
Fourth St. Bridge, Construction.....	Thomson Bridge Co.....
Submarine Cables, Third St. Bridge.....	Butte Eng. & Elect. Co.....
Evans Ave. Bridge at Selby St.....	Duncanson-Harrelson Co.....
Repairs to Sixth St. Bridge.....	*Healy Tibbitts Const. Co.....
San Bruno, Vista to Bay Shore.....	City St. Imp. Co.....
Twin Peaks Blvd., Corbet Ave. to Sly boundary line of Twin Peaks Reservoir Site.....	F. R. Ritchie.....
Clarendon and Burnett Aves., St. Germain Ave. to Clayton St.....	Flinn & Treacy.....
Corbett Ave., 24th St. to San Miguel Rancho.....	D. L. Bienfield.....
Potrero Ave. Extension, 25th St. to San Bruno Ave.....	Eaton & Smith.....
Marina Boulevard fill, Buchanan to Scott St.....	*J. P. Holland.....
Marina Boulevard fill, Buchanan to Scott St.....	*J. O'Shea
Hauling and Laying High Pressure Mains, Telegraph Hill, Pine St. and First St.....	E. M. Whitlock.....
Clarendon Ave., St. Germain to Clayton St.....	Flinn & Treacy.....
Section "A" Ocean Beach Esplanade.....	J. D. Hannah.....
Section "B" Ocean Beach Esplanade.....	J. D. Hannah.....
Municipal Water Works Extension.....	Tibbitts Pacific Const.....

* Informally awarded.

BUREAU OF ENGINEERING

51

PLY AND STREET IMPROVEMENTS - FISCAL YEAR 1916-1917

S

Date of ward	Date of Signing	Amount Expended			Accept- ance	Fund
		Prior to July 1, 1916	From 7/1/16 To 7/1/17	Total		
20 15	1/3 16	\$ 28,144.43	\$ 11,688.75	\$ 39,833.18	8/11/16	General
31/16	6/13/16	2,415.09	15,099.86	17,514.95	10/25 16	General
9 16	6/20/16		17,993.60	17,993.60	11/3/16	General
6, 16	9/21/16		5,224.58	5,224.58	11/11/16	General
1 16	11/8 16		(1,000.00	1,000.00	3/9/17	1904 Bonds
			(18,117.31	18,117.31		General
13 16	11/29/16		6,491.11	6,491.11	3 16, 17	General
20/16	11/13/16		37,930.30	37,930.30	5/16/17	General
30 17	4/7 17		4,429.46	4,429.46	6/19/17	General
17, 17	2/20/17		(19,337.66	19,337.66		1904 Bonds
			(360.00	360.00		General
17 17	2/7/17					General
4/17	5/18/17					General
15/17	6/29/17					General

LS

2 14	11/2/14	2,276,604.32	1,706,765.35	3,983,369.67		Special Asst.
11/13	4 26 13	638,285.03	8,448.27	646,733.30	11/19/15	Special Asst.

S

19/16	4/29/16	2,487.00	498.30	2,985.30	10/11/16	General
25/15	7/8/15	51,858.25	54,650.93	106,509.18	2/2/17	General
25, 16	9 14/16		3,994.00	3,994.00	1/31/17	General
26/17	2 6, 17		2,000.00	2,000.00	3/9/17	General
1 16			1,225.00	1,225.00	12 '8/16	General

RDS

11/15	7/24 15	33,537.15	10,199.13	43,736.28	1/14/16	General
20 15	10/11/15	46,364.47	17,825.10	64,189.57	10/9 16	Good Roads
15 16	6/7 16	112.50	4,376.78	4,489.28	3/16/17	Good Roads
29 15	1/21/16	22,600.00	2,254.22	24,854.22	8/4/16	Good Roads
21 16	7 12 16		37,232.31	37,232.31	2/26/17	Good Roads
28 17			(1,451.00	1,451.00		Good Roads
28/17			(			Good Roads

PLY SYSTEM

11 16	10/25/16		11,858.70	11,858.70	2 15, 17	1908 Bonds
15/16	6/7 16		723.00	723.00	3 16/17	1908 Bonds

NEOUS

19 15	12/6/15	(25,963.45	53,827.38	79,790.83	6/20/17	General
21/16	8/2/16	(
24 16	4/7/16	1,831.13	47.74	1,878.87	10, 11/16	General

CONTRACT EXPENDITURES EXCLUSIVE OF HETCH HETCHY WATER SUPPLY

MISCELLANEOUS

Contract

Contractor

Railroad Ave., Hollister to San Bruno Ave.....	J. P. Holland.....
18th and Indiana Sts. Crossing—Steel Stairway.....	Ralston Iron Works.....
Islais Creek Channel Dredging.....	Healy-Tibbitts Const. Co.....
	J. P. Holland.....
Relief Home Tract Boiler, Proposition No. 1.....	Scott Company.....
Relief Home Tract Boiler, Proposition No. 4.....	F. P. Walsh.....
Northerly $\frac{1}{2}$ Division St., Bryant to 10th St.....	Fay Improvement Co.....
Extension Municipal Water Mains, University Mound District.....	H. P. Broderick.....
Pumping Equipment, Relief Home Water Supply.....	Simonds Machinery Co.....
Drilling Well, City Hall Property.....	J. B. Rodgers.....
Westerly $\frac{1}{2}$ Hampshire St., 17th to Mariposa St.....	D. J. Counihan.....
	R.....
Machine Shop Equipment at Pipe Yard.....	(Various).....
Furnishing and Installing Electrical Conductors, Church St., 16th to 18th and 22nd to 30th Sts.....	E. Earle Browne.....
Furnishing and Installing Copper Rail Bonds.....	Bell & Jamison.....
Concrete Trolley Poles for Church St., 16th to 18th and 22nd to 30th Sts.....	John Spargo.....
Church St. Rwy. Construction, 18th to 22nd St.....	Contra Costa Const. Co.....
Church St. Rwy. Const. Narrowing Sidewalks, 14th to 16th St.....	Board of Public Works.....
Concrete Poles; Division St., Bryant St. to Potrero Ave.....	*H. S. Tittle.....
Electrical Conductors—16th and Church Sts. to Van Ness Ave. and Market St.....	*H. S. Tittle.....
Track Special Work, Contract No. 82.....	U. S. Steel Products Co.....
Trolley Poles; 16th and Church Sts. to Van Ness Ave. and Market.....	John Spargo.....
Auto Buses.....	White Company.....
Conduit Materials—Church St. and Market St., East of Van Ness Ave. and West of Church St.....	H. W. Johns-Manville Co.....
Copper Trolley Wire.....	Telephone Elec. Equip. Co.....
Electrical Cables and Splicing Materials; Church and Market St., 3rd St. to T. P. Tunnel, except Van Ness to Church.....	Stand. Underground Cable.....
Electrical Conductors and Splicing Materials, Twin Peaks Tun- nel Railway, C-89.....	Stand. Underground Cable.....
Rails, Plates, etc., Market St. Railway, Twin Peaks Tunnel to Geary and Market Sts.....	U. S. Steel Products Co.....
Rails and Joint Plates, Twin Peaks Tunnel Railway.....	U. S. Steel Products Co.....
Tie Plates Market St., Twin Peaks Rwy. to Sect. "A".....	Eccles & Smith.....
Tie Plates Market., Twin Peaks Tunnel Rwy. to Sect. "D & E".....	U. S. Steel Products Co.....
Track Specials, Crossings, etc.; Market and Church to Market and Van Ness and Twin Peaks Tunnel Railway.....	U. S. Steel Products Co.....
Twin Peaks Tunnel Railway Construction, C96.....	Eaton & Smith.....
Ties for Municipal Railways, C90.....	A. P. Mahoney.....
Potrero Ave. Extension, 25th St. to Army St.....	Eaton & Smith.....
Potrero Ave. Rwy. Ext., 25th to Army St.; Poles and Wires.....	(Various).....

* Informally awarded.

D STREET IMPROVEMENTS—FISCAL YEAR 1916-1917—Continued.

Continued

Date of ward	Date of Signing	Amount Expended—			Acceptance	Fund
		Prior to July 1, 1916	From 7/1/16 To 7/1/17	Total		
28 16	5 24 16	1,027.55	2,269.10	3,296.65		Good Roads
15 16	6 15/16	11.00	589.10	600.10	10 18/16	General
2 16	2/23 16	4,116.37		4,116.37	5 26/16	General
7/16		882.50		882.50	2/2/16	General
4 16	7 25 16)	1,214.30	13,323.00	14,537.50)	9 25/16	General
4 16	2 28 16)				4 27/17	General
11 16	10 27/16		2,405.19	2,405.19	12 27 16	General
16/16	12/7 16		5,094.87	5,094.87	4 4 17	General
27/17						General
24/17	6/12/17					General
9/17	4 26/17					General
YS		7,519.91	81.75	7,601.66		1913 Bonds
11/16	2 25/16	3,353.31	5,847.87	11,201.18	8 9/16	1913 Bonds
20 14	4 2 14	32,668.75	1,388.25	34,057.00		1913 Bonds
19 16	2 3 16	6,404.41	250.00	6,654.41	8 9/16	1913 Bonds
10 15	12/27 15	93,371.79	33,976.54	127,348.33	10/11/16	1913 Bonds
			2,517.66	2,517.66		
16/17			420.00	420.00	5 9 17	
18/17	4 31/17	683.55	6,241.65	6,925.20	8 24 17	1913 Bonds
5/16	7 19/16		16,420.94	16,420.94		1913 Bonds
16/17	4/30/17		5,152.04	5,152.04		1913 Bonds
19/17	3 8/17					Munic. Ry.
4/17						Munic. Ry.
19/17	2 27 17		13,741.68	13,741.68	6 20 17	Munic. Ry.
19/17	4 4 17		6,866.25	6,866.25		Munic. Ry.
4/17	1 13/17		16,186.37	16,186.37		Munic. Ry.
18/16	9 2 16		37,540.88	37,540.88		Munic. Ry.
18/16	9 2/16		29,508.23	29,508.23		Munic. Ry.
23 17	4 7 17		11,380.15	11,380.15	6 13 17	Munic. Ry.
23/17	4 23 17		3,319.14	3,319.14	6 15 17	Munic. Ry.
5 16	7 19 16		9,232.00	9,232.00		Munic. Ry.
21 17						Munic. Ry.
7 17	5 31/17		11,550.00	11,550.00		Munic. Ry.
23/16	11 8 16		7,171.77	7,171.77	1 31 17	Munic. Ry.
			562.12	562.12		Munic. Ry.

MUNICIPAL RAILWAYS

Church Street Line:

The Church Street Line of the Municipal Railway commenced operation on the 11th of August, 1917. The placing of this road in operation marks the completion of the final link of the extensions contemplated under the Bond Issue of 1913, when the citizens of San Francisco voted \$3,500,000 for extending the Municipal Railway System by the construction of some 12 miles of double track and the purchase of the Presidio & Ferries Railroad or the so-called Union Street Line comprising 3.78 miles of double track.

In the last Annual Report of the Bureau of Engineering there was presented in detail a chronology of the public proceedings had in connection with the construction of the Church Street Line, so that it is sufficient here but briefly to touch upon this earlier history.

The Church Street Line contemplated under the provisions of the Bond Issue consisted of an extension of the Municipal Railway System from Van Ness Avenue and Market Street, out Market Street to Church and over Church Street to 30th Street. For a number of reasons, in constructing this road, it was considered necessary to divide the line into three sections:

Section "A" from Van Ness Avenue and Market Street to 16th and Church Streets; Section "B" from 18th and Church Streets to 22nd and Church Streets; and Section "C" from 16th and Church Streets to 18th and Church Streets and from 22nd and Church Streets to 30th and Church Streets.

Section "A" included that portion of the line in which it was anticipated that legal difficulties and obstacles would be placed in the City's way by the United Railroads. Section "B" covered that portion of the road where a diversion was made from Church Street through Mission Park and a private right of way, which involved the acquisition by condemnation or purchase of a large number of small parcels

of land, and Section "C" comprised that portion upon which no unusual conditions existed.

Section "C" was completed April 29, 1916. Section "B" was completed June 28, 1916, and Section "A," the last link to be finished, was completed on the 1st of August, 1917.

This latter contract was awarded to the Western Motor Drayage Company on the 16th of March, 1917. The completion of this contract was contingent upon the delivery of the track special crossings of manganese steel which had to be manufactured and delivered from the East, after the last legal obstacle in the way of the construction of the line had been removed.

In order to expedite this work to the fullest degree, this office had prepared the necessary plans and specifications and the Board of Public Works had advertised for bids and entered into a contract with the United States Steel Products Co. for the delivery of these special track castings within 90 days after the receipt of the order. This arrangement in effect gave the City an option on this material, which was to be exercised in the contingency of a favorable decision from the United States Court, to which the United Railroads had appealed for an injunction to prevent the construction of parallel tracks on Market Street and on Church Street.

On January 18, 1917, Judge Wm. H. Hunt, of the United States District Court handed down a decision of the most momentous import to our Municipal Railway System. In his decision, in which he denied the injunction sought, he stated:

"It is accepted that the destruction of the franchise is not possible, but even so, in the complexities of modern society new conditions present themselves which may call for the safeguarding of the public interest in a way which justifies the application of the doctrine that the police power may extend to all great public needs."

And further:

"There being no statutory rule against one street railway company from crossing the tracks of another, I do not find that compensation must first be paid for the crossing."

In his opinion, he quotes, from the case of the Consolidated Traction Company vs. the South Orange and Maplewood Traction Co., in which the Court held that,

“Although the crossing necessitates some actual interference with tracks as constructed and to some extent changes thereafter the exclusive use by the one company of its crossings, still such changes are the necessary result of the development of the method of operating electric roads at their points of crossing, and are such as are made necessary as the best and safest methods now attainable for the safety and convenience of the public in the operation of both roads at the point of crossing: that they are changes and burdens in the use of its tracks and trolley system to which the original right to lay and construct them was necessarily subject.”

Immediately upon the receipt of Judge Hunt's decision the United States Steel Products Company was ordered to proceed with the manufacture of the crossings for Section “A” of the Church Street Line. While these crossings were being manufactured, the specifications were prepared and bids advertised for the construction of the track work on this section and also for the erection of the poles and overhead electrical work.

In connection with the question of poles for this section of the line, this office took up with the United Railroads the question of entering into an agreement with that Company for the use of the existing poles on Market Street and on Church Street in order to avoid the unnecessary duplication of poles on these streets, suggesting as a basis for the agreement the so-called Joint Pole Agreement which is in effect between the various public service corporations of the City, under which any company is allowed to use the poles of another corporation by paying the proportional cost for the pole, or other equitable arrangement. This the United Railroads refused to do, whereupon the City entered into a contract for the erection of a second set of poles on Market Street from Van Ness Avenue to Church Street and on Church Street from Market to 16th Street. While these poles were being manufactured, but before they were placed in position, the Chairman of the Public Utilities Committee, Supervisor Edward I. Wolfe, appealed directly to Mr. Lilien-



Mission Park Bridge—Church Street Municipal Railway.

thal, President of the United Railroads, to reconsider his objection and allow the City to use the United Railroads' poles. Mr. Lilienthal, after further review, yielded and the Contractor was directed not to set the poles.

After the award of the contract for the construction of Section "A," when the Board of Public Works requested the Supervisors to appropriate the amount of the contract, an effort was made by individuals representing different interests to effect an agreement between the City and the United Railroads, which would obviate the necessity of constructing these additional tracks on Market Street. The consideration of these questions by the Board of Supervisors consumed several weeks before they decided to proceed with the construction of outer tracks from Van Ness Avenue to Church Street, but with the expressed intention of a number of the members of the Board that the further construction of tracks on Market Street, that is, between Kearny Street and Van Ness Avenue and between Church Street and Castro Street, would not proceed until further effort had been made to reach an agreement looking to the use of the United Railroads tracks on this portion of Market Street.

Twin Peaks Tunnel Line:

R. C. Storrie & Co., who have the contract for the construction of the Twin Peaks Tunnel, completed their work early in July, 1917, and the 14th day of July was set as the day to celebrate the completion of the Twin Peaks bore. At the completion of the dedication ceremonies the construction of the railway through the Twin Peaks Tunnel will be commenced.

The contract for the construction of the railway through the tunnel was awarded to Eaton & Smith for the sum of \$80,467.25. This contract is for double track overhead electric railway from the East Portal of Twin Peaks Tunnel near Castro Street, through the tunnel, and over West Portal Avenue to the junction of Sloat and Junipero Serra Boulevards. The trolley wire, rails, ties, tie plates and other track material for this work are being furnished by the City, hav-

ing been purchased under contract over a year ago, in order to assure their being on hand when the work was ready to commence.

The type of track to be installed through the tunnel is what is known as ballasted open track construction. The rails weigh 70 pounds per yard and are in 60 foot lengths through the tunnel. This longer length of rail was adopted for use in the tunnel to secure smoother, quieter operation by the reduction of the number of joints. The longer length rail has the further advantage of reducing the cost of maintenance and of bonding. This length of rail is not generally adopted for railroad construction in the open as the allowance at the joints to care for expansion due to temperature changes in exposed work becomes excessive. This objection does not hold in the tunnel, where there will be comparatively small temperature changes, permitting the joints to be laid close.

The type of overhead trolley work is what is known as the catenary suspension type. In this construction as adopted the trolley wire is supported at 12 foot intervals from a separate steel cable $\frac{3}{8}$ inch in diameter, which is stressed in tension to approximately 1800 pounds. The frequent points of support maintain the trolley wire at practically a uniform elevation above the track, thereby avoiding the sparking and wear found at the points of support in the ordinary type of construction. This will also in a large measure reduce noise in the tunnel by eliminating any rigid connection between the trolley wire and the suspended ceiling in the tunnel.

The construction of this Twin Peaks Tunnel line will be completed on or before December 1, 1917, and it is hoped that by the time it is completed some solution will be had for operating cars directly down Market Street and connecting with the existing lines west of the Twin Peaks.

The schedule time for cars through the Tunnel will be 6 minutes and 23 seconds eastbound, and 7 minutes 16 seconds westbound, allowing for stops at both stations.

The running time of the United Railroads cars from 17th and Market Streets to the Ferry at the present time is 20 minutes. If outer tracks are constructed on Market Street to Kearny Street this time will be reduced at least 3 minutes. This will make the running time from Sloat Boulevard to the Ferry 26 minutes, or about 20 minutes less than the time now required.

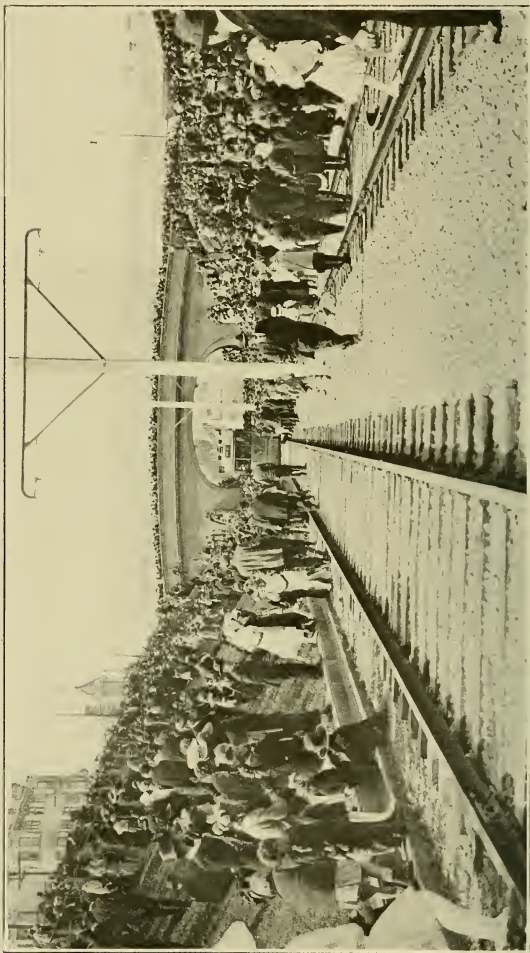
Four-Tracking Market Street:

When the routes for the extensions to serve the Exposition were determined upon prior to the bond election of 1913, the City Engineer realized that there would be serious opposition encountered to the construction of tracks on Market Street from Van Ness Avenue to Church Street. To guard against this the enacting ordinance was so framed as to permit a suitable connection from Van Ness Avenue and Market Street to Church Street, it being in mind, in event of an adverse decision of the Courts, that this connection could be made by leaving Market Street after five blocks.

This Department made an effort to start the construction of this section of the line first, in order that the legal difficulties might be met and solved in advance of constructing the remaining portion of the work. This idea met with the opposition of certain members of the Board of Supervisors who desired to have the plan for overcoming the grades on Church Street adopted first. The result of this departure from the Engineer's recommendation was to have Section "B" and "C" of the Church Street road, that is, the portion south of 16th Street on Church Street, completed and lying idle for one whole year awaiting the determination of the City's rights on Market Street.

After the above condition was created, this Department evolved a plan under which, by a temporary transfer agreement made with the United Railroads, the Church Street Line could be operated from 30th to Market Street. This temporary transfer agreement was rejected by the Board

of Supervisors and upon the United Railroads refusing to allow a connection to be made with their tracks at 16th and Church Streets, after having agreed to sell to the City a one-half interest in those tracks on Church Street, the Board of Supervisors passed a resolution directing the Board of Public Works to proceed with the construction of outer tracks on Church Street from 16th to Market Street and on Market Street from Church Street to Van Ness Avenue. The Supervisors further, by resolution, directed the Board of Public Works to prepare plans for the construction of outer tracks on Market Street from Kearny Street to Van Ness Avenue and from Church Street to the East Portal of Twin Peaks Tunnel. Thereafter in order to bring the matter into the Courts and secure the earliest possible decision as to the City's rights on Market Street, upon the recommendation of the City Engineer, the Board of Public Works adopted a resolution authorizing the City Engineer to construct outer tracks on Market Street and Church Street by day labor. Immediately following the passage of this resolution work was commenced at the intersection of Van Ness Avenue and Market Street to install a crossing in the United Railroads tracks. On the following day an injunction was served on the Board of Public Works and the City Engineer restraining them from further work on this construction, and on August 22nd, 1916, Judge Wm. H. Hunt, United States District Court, commenced the hearing of the case, which hearing was completed on the 25th of August. On the 18th of January, 1917, as noted before, a decision favorable to the City was returned. As before referred to, following the award of contract for Section "A" of the Church Street Line, when the appropriation was requested to cover the contract price, considerable opposition developed to the construction of outer tracks on Market Street. After extended deliberation the Supervisors finally appropriated the money so that the contractor could proceed with that portion of the work from Van Ness Avenue to Church and 16th Streets.



Dedication Ceremonies—Church Street Railway.

At the time the question of appropriation was being considered by the Board of Supervisors, Mr. Lilienthal, President of the United Railroads, made a proposal under the terms of which the City would be allowed to operate its Church Street cars over the Market Street tracks of the United Railroads to Van Ness Avenue on a mileage basis, and to route the Twin Peaks Tunnel cars down Market Street to the Ferry. This offer was rejected by the Board of Supervisors as far as its application to Section "A" of the Church Street road was concerned, but with the idea and the expressed intention of a number of the Board that when the question of appropriations for constructing the outer tracks connections on Market Street from Van Ness Avenue to Geary Street and from the Tunnel to Church Street already authorized by Ordinance of the Board of Supervisors should come up, further consideration would be given to the offer of the United Railroads. In the meanwhile, as time was running against the consummation of our transportation plans, it was essential that some decision be reached as to the policy to be adopted in order that the necessary material could be purchased. To develop a definite policy and bring the matter to a focus, this office took such steps as were within its province and certain negotiations were had with the United Railroads. The exchange of correspondence on this four-tracking proposition is herewith presented in full.

UNITED RAILROADS OF SAN FRANCISCO

58 Sutter Street

President's Office

San Francisco, January 29, 1917.

Honorable the Mayor and Board of Supervisors
of the City and County of San Francisco.

Dear Sirs: Not alone as President of the United Railroads but more particularly as a citizen who knows that he is always ready to place the public welfare above private interests, I earnestly recommend to your Honorable body the postponement of the proposed action to parallel the tracks of the Company until at least the City Engineer and our General Manager will have had an opportunity to

confer with a view to devising some plan that will provide a fair solution of pending transportation problems.

It will be admitted that the proposed construction on Market Street will prove an unprofitable financial operation for the City, and, if allowed to be permanent, will amount to confiscation of property of the Company. To the extent that the municipal lines have money to spare to build extensions, it would seem to be the part of wisdom to apply such surplus to building lines in sections of the city which are not yet provided with adequate transportation rather than in places already sufficiently supplied.

I am sure that if this matter be approached in the spirit that should dominate such a negotiation, a solution can be found that will redound to the advantage of all the people of the city.

Yours very respectfully,

(Signed) JESSE W. LILIENTHAL,

President, United Railroads of San Francisco.

Jan. 29, 1917. Read and referred to Public Utilities Com.

CITY'S SUGGESTED SOLUTION

February 1, 1917.

1. Church Street to the Ferry, 15 cars at present, more later when Bernal Cut is in operation.

2. City to operate 10 tunnel cars to Ferry, both tunnel and Church Street cars to be on mileage basis to be determined, tunnel cars to be routed on Ocean Avenue to Mirimar Avenue.

3. Full transfers to be put into effect, affecting connecting lines.

4. United Railroads construct tracks on Taraval Street from ocean to the tunnel portal with right to operate until 1933, when City will take new tracks at physical value, United Railroads to readjust operation of remaining Parkside lines.

5. City furnish power Church Street and tunnel lines with interconnections between both feed systems for emergency.

6. United Railroads to facilitate construction and operation of cross-town tracks by the City on Army Street from Church Street to Third Street (Kentucky Street). (This means general exchange of transfers.)

7. Should congestion from proposed arrangements crowd Market Street then United Railroads would reroute some of its north of Market Street lines down Mission Street.

PROPOSALS FOR MARKET STREET OPERATION

UNITED RAILROADS

(a) The City to operate the Church Street line on Church Street from 16th Street, and on Market Street from Church Street to Van Ness Avenue over the tracks of the United Railroads, and then north on Van Ness Avenue.

(b) The City to operate the Parkside lines and give direct service through the tunnel to ferry over the tracks of the United Railroads from the tunnel to ferry on a headway limited to that necessary to serve Parkside, approximately 5 minutes. The City to also operate the tunnel lines from the West Portal over Ocean Avenue to Miramar Avenue.

(c) United Railroads to make a transfer agreement on a 50/50 basis at 20th Avenue and Lincoln Way and at Miramar and Ocean Avenues for Parkside operation, and Church Street and tunnel lines on Market Street to transfer to connecting Municipal lines.

(d) The City to pay for the use of tracks and power of the United Railroads on Parkside lines and on Market and Church Streets on a mileage basis at a rate to be agreed upon.

(e) This agreement to continue subject to termination at the option of either party on twelve (12) months' notice.

UNITED RAILROADS OF SAN FRANCISCO

58 Sutter Street

San Francisco, Cal.

William von Phul

Vice President & General Manager

February 2, 1917.

Mr. M. M. O'Shaughnessy,
City Engineer,
San Francisco, Cal.

Dear Sir: I beg to enclose you, herewith, a copy of the proposal which we will make to the Public Utilities Committee this afternoon covering the proposed operation on Market Street.

Yours truly,

(Signed) Wm. VON PUHL,
Vice President & General Manager.

UNITED RAILROADS OF SAN FRANCISCO

58 Sutter Street
San Francisco, Cal.

William von Phul

Vice President & General Manager

February 2, 1917.

PROPOSAL FOR MARKET STREET OPERATION

UNITED RAILROADS

(a) The City to operate Church Street line on Church Street from 16th Street, and on Market Street from Church Street to Van Ness Avenue over the tracks of the United Railroads, and then north on Van Ness Avenue.

(b) The City to operate the Parkside lines and give direct service through the tunnel to ferry over the tracks of the United Railroads from the tunnel to ferry on a headway limited to that necessary to serve Parkside, approximately 5 minutes. The City to also operate the tunnel lines from the West Portal over Ocean Avenue to Miramar Avenue.

(c) United Railroads to make a transfer agreement on a 50/50 basis at 20th Avenue and Lincoln Way and at Miramar and Ocean Avenues for Parkside operation, and Church Street and tunnel lines on Market Street to transfer to connecting Municipal lines.

(d) The City to pay for the use of tracks and power of the United Railroads on Parkside lines and on Market and Church Streets on a mileage basis at a rate to be agreed upon.

(e) This agreement to continue subject to termination at the option of either party on twelve (12) months' notice.

(Note.—Submitted to Public Utilities Committee on this date—not adopted.

On Feb 5.—Supervisors passed ordinance authorizing contracts to be let for outer tracks on Market Street). NAE

UNITED RAILROADS OF SAN FRANCISCO

58 Sutter Street

President's Office

San Francisco, March 28, 1917.

Honorable Mayor and Board of Supervisors
of the City and County of San Francisco.

Dear Sirs: I had occasion in a recent communication to say to you that, notwithstanding the official position which I occupy with the United Railroads, I knew that I was always ready to place the public welfare above private interests, and in that spirit I take the

liberty to urge upon you not to carry out the proposed plan for the paralleling of the tracks on Market Street.

The Company is willing that the City should operate its Church Street line from 16th Street on Church Street and on Market Street from Church Street to Van Ness Avenue on the tracks of the United Railroads on a mileage basis.

The Company is further willing that a limited number of Church Street cars be operated over the tracks of the United Railroads to the Ferry upon a similar mileage basis; and to make a transfer agreement, on a 50-50 basis, providing for exchange between the Church Street line and our Market Street lines.

With this disposition on the part of the Company, I permit myself to say that there does not appear to be any warrant for the proposed expenditure of city moneys, because the desired transportation facilities would be provided for without further expenditure. In view of the crying need of many districts in the city for transportation facilities which the Company under existing charter conditions is not able to provide, it would seem that any city moneys that may be available should be applied to providing such transportation facilities rather than to duplicating existing ones, with the economic waste that that would involve.

I am making a proposal, at great financial sacrifice to the Company, which should in my opinion be acceptable to you in the interest of all the people, but if any modification of same is desired by you I shall be glad to receive your further suggestions.

Very respectfully yours,

(Signed) JESSE W. LILIENTHAL,

President.

CITY'S SUGGESTED SOLUTION, AS MODIFIED APRIL 16, 1917

1. Church Street to the Ferry, 15 cars at present, more later when Bernal Cut or other connections are in operation, on mileage basis.

2. City to operate 10 tunnel cars at present to Ferry, both tunnel and Church Street cars to be on mileage basis to be determined, tunnel cars to be routed on Ocean Avenue to Miramar Avenue.

3. Full transfers to be put into effect, affecting connecting lines.

4. United Railroads to construct tracks on Taraval Street from Ocean to the tunnel and operate through the tunnel on mileage basis over City tracks, with right to operate until 1933, when City will take new tracks at physical value, United Railroads to readjust operation of remaining Parkside lines.

5. City furnish power to Church Street and tunnel lines with inter-connections between both feed systems for emergency.

6. United Railroads to facilitate construction and operation of cross-town tracks by the City on Army Street from Church Street to Third Street (Kentucky Street). (This means general exchange of transfers.)

7. Should congestion from proposed arrangements crowd Market Street then United Railroads would reroute some of its north of Market Street lines down Mission Street.

(Signed) M. M. O'SHAUGHNESSY,
City Engineer.

CITY AND COUNTY OF SAN FRANCISCO

Department of Public Works
Bureau of Engineering

April 23, 1917.

Mr. Jesse W. Lilienthal,
President, United Railroads,
San Francisco, California.

Dear Sir: Your letter of March 29, 1917, addressed to the Mayor and the Board of Supervisors on the subject of the operation of the Church Street line, in which you have made certain offers looking to an agreement covering the operation of this line of the Municipal Railway System over your tracks, was, as you know, referred to the Public Utilities Committee, who have requested that I take the matter up with you in order that the suggestions made might be more thoroughly and definitely understood and, if feasible, some recommendation made looking toward an agreement satisfactory to both the City and to yourselves.

To amplify and make more concrete your offer, will you kindly answer the following questions:

FIRST—What charge would the United Railroads propose to make to the City for the use of the United Railroads tracks and power as contemplated in your letter? If you are not prepared at this time to state this as so many cents per car mile, will you state exactly what elements would go to make up this charge, and, particularly, if this mileage charge would be such as to cover any loss which the United Railroads feel they might sustain due to the City's parallel operation of your lines.

SECOND—Will you state definitely the number of Church Street cars which you would agree to allow the City to operate through to the Ferry on the inner Market Street tracks during the rush hours and at other periods. Before the Board of Supervisors you stated

that this number would be limited only by the number that could be so operated without curtailing the existing service of the United Railroads.

THIRD—Does the offer of the United Railroads contemplate the use of the inner tracks on Market Street to the Ferry for the cars of the Municipal Railways to be operated through the Twin Peaks Tunnel, and, if so, how many as a minimum? The use of the United Railroads Market Street tracks for the Tunnel cars is not covered in your letter, but I believe that verbally before the Board of Supervisors you stated that this was not intentionally omitted.

FOURTH—Further, along the line of question number three, does your offer contemplate allowing the City to use your Ocean Avenue, Sloat Boulevard and Parkside tracks on a similar mileage basis for Tunnel cars.

FIFTH—Does the offer of the United Railroads contemplate the exchange of transfers between any other lines of the United Railroads and the Municipal Railways than the Church Street and the Market Street lines mentioned, as, for instance, transferring on a transfer from the Church Street line; at Ocean Avenue and Miramar; and at 19th and Sloat; or 20th and Lincoln Way; or at any other points?

SIXTH—Is it your intention that such* agreement would extend to the expiration of your Market Street franchise, or would it be terminable following the decision of the United States Supreme Court to which I understand it is the intention of your Company to carry its appeal from the decision of Judge Hunt?

As you will recognize, all of these questions are pertinent to the subject and before I can make any recommendation to the Public Utilities Committee it is necessary that I have a thorough understanding on all these points.

Yours truly,

(Signed) M. M. O'SHAUGHNESSY,
City Engineer.

June 20, 1917.

Mr. Jesse W. Lilienthal,
President, United Railroads,
58 Sutter Street, City.

Dear Sir: On April 23, 1917, a conference was held in my office to discuss transportation facilities for the district west of Twin Peaks and the operation of Municipal cars on Market Street. This conference was attended by Mr. von Phul and yourself of the United Railroads and Supervisor Wolfe, my assistant, Mr. Eckart, and myself.

The subject of your proposal of March 29, 1917, addressed to the Mayor and the Board of Supervisors, in which you expressed your willingness to allow the City to use your tracks on Market Street for the tunnel cars and a limited number of Church Street cars, was brought up. You thereupon stated that the City's decision to construct outer tracks on Market Street between Church Street and Van Ness Avenue was taken by the United Railroads to be a rejection of the proposal submitted and that the offer was no longer open for consideration. You further stated, however, that you were willing and would prepare and submit a new proposition covering the most favorable offer you could make to the City under existing conditions.

At the time also I handed to you for your consideration a memorandum of date of April 16 covering certain definite propositions which would be satisfactory to the City.

Up to the present time we have not received either the new proposition from the United Railroads or a response to the proposal of the City. As the time is rapidly approaching when a definite decision must be made as to the policy to be pursued on Market Street, I take the liberty of again calling this matter to your attention and to urge upon you an early response.

Trusting that you will realize the urgency of the situation, I am

Yours truly,

M. M. O'SHAUGHNESSY,
City Engineer.

UNITED RAILROADS OF SAN FRANCISCO

58 Sutter Street

President's Office

San Francisco, June 22, 1917.

Hon. M. M. O'Shaughnessy,

City Engineer,

City Hall, San Francisco, Cal.

Dear Sir: I have your favor of the 20th inst.

You will appreciate that for the next few days I shall have to neglect all of my usual duties in devoting my time to the Red Cross campaign, but as soon as this is ended I shall give careful attention to the request made by you.

Yours very truly,

(Signed) JESSE W. LILIENTHAL,

President.

UNITED RAILROADS OF SAN FRANCISCO

58 Sutter Street

President's Office

San Francisco, July 2, 1917.

His Honor, the Mayor, and the Board of Supervisors
of the City and County of San Francisco.

Dear Sirs: In view of the early completion of the tunnel and the necessity of providing for immediate use of the improved facilities thus made available and realizing the great importance and benefit to the citizens of San Francisco of a unified system of transportation, we submit for your consideration a plan of operation which will obviate the necessity of duplicating transportation facilities on Market Street.

We propose that the City and the Company agree:

1. That the Company re-arrange such part of the present Parkside lines as may be necessary to furnish the best service to the Sunset District, and make connections from these lines to the tunnel tracks;

2. That the Company pay the City on a mileage basis, for the use of the City's tracks through the tunnel;

3. That there be established between the City and the Company a universal exchange of transfers at all connecting points so that a unified system of transportation may be furnished;

4. That the City agree that no further tracks be built on Market Street and that the City will operate its cars over Market Street as at present, except for that portion of Market Street from Church Street to Van Ness Avenue forming part of the Church Street Line.

5. That should an agreement be entered into on the above basis, such agreement to be subject to cancellation by either party upon six months' notice; with the further proviso that, should the agreement be cancelled by the City, then the City to reimburse the Company for the cost of the reconstruction of its Parkside lines that may be agreed upon, as well as for the cost of making connections of the tunnel tracks with the existing tracks of the Company.

Very respectfully,

(Signed) JESSE W. LILIENTHAL.

President, United Railroads of San Francisco.

Motor Buses:

In response to a request of the Public Utilities Committee of the Board of Supervisors, that this office report upon the route for a motor bus line in connection with the Municipal Railways across Golden Gate Park and the cost of operating same, the following report was submitted:

San Francisco, September 6, 1916.

To the Honorable Public Utilities Committee
of the Board of Supervisors, San Francisco.

Gentlemen: In response to your request that this office prepare and submit to the Public Utilities Committee data on the cost of operation of and routing of motor buses in connection with Municipal Railway across Golden Gate Park, I beg to submit the following:

The route selected for motor bus operation is from 10th Avenue and Fulton Street across the Park to 9th Avenue and Lincoln Way, thence to Judah Street and out Judah Street to 33rd Avenue, with the view of future extension out towards the ocean, as circumstances may warrant.

The round trip length of this route is 5 miles. The schedule assumed calls for a headway of from 7 to 12 minutes, with a view of meeting and connecting with the alternate cars on the "A" line as now operated. This will require four buses in service during the rush hours and a total of 120 round trips per day. This, with the dead mileage to and from the car barn, will require 625 bus miles per day.

An investigation has been made as to cost of operating several types of buses. These figures, including original investment (for 5 buses, one spare being deemed necessary), depreciation, interest, administration charges, maintenance and operation expense, range from 12.1 cents to 15.6 cents per bus mile, assuming 13 cents, the average daily cost would be \$81.25.

The cash receipts alone of the bus line would not warrant its installation but it is estimated that when considered with the increased receipts on the "A" line, the installation of this bus line would be justified, in view of the fact that the increased traffic would be handled without the addition of any more cars on this route.

With the development of the district through which the buses operate and the extension of this bus system to other districts the system will soon be put on a money making basis.

It should be borne in mind that the construction of tracks on a street is an indication to the property owners and prospective home

builders of an assured service for all future time, whereas with a bus line it is within the power of the governing authorities to change the route or terminate the operation of the bus system at will. The effect of this uncertainty could be minimized by the establishment of a fixed policy to continue the bus service through any district where it is once established until such time as the traffic density would warrant the construction of street car tracks.

This office feels that the automobile bus has its place in the solution of the transportation problem in San Francisco, particularly in pioneering the development of thinly settled but growing districts, and it is felt that the investment involved in the installation of a bus line connecting with the present terminal of the "A" line at 10th Avenue and Fulton Street would be fully justified in that it would give service to a growing district for some years prior to the construction of a permanent street car line.

The route across the Park is necessarily somewhat tortuous, which would add somewhat to the danger of operation across the Park, particularly at night. In this connection opportunity is taken to direct your attention to the desirability of a surface road crossing the Park in this vicinity with depressed crossing at the main drives, to give a proper connection for ordinary traffic between the Sunset and Richmond Districts.

Respectfully,

(Signed) M. M. O'SHAUGHNESSY,
City Engineer.

Following the submission of this report and upon the recommendation of the Public Utilities Committee the Board of Supervisors adopted a resolution directing the City Engineer to prepare plans and specifications for auto buses suitable for use in conjunction with the Municipal Railways. In accordance with this resolution specifications were prepared by the City Engineer and approved by the Board of Supervisors, which then authorized and directed the Board of Public Works to advertise for bids and enter into contracts for the purchase of these buses.

The motor buses for which bids were invited are of the enclosed semi-convertible type, adapted for one man operation. The bus is arranged with a combination of longitudinal and transverse seats and will carry 18 seated passengers with accommodations for 11 standing passengers. They are

equipped with pneumatic tires, insuring a maximum of comfort and a prolonged life of the motor equipment. The exterior will be painted and finished to match the standard municipal cars. The buses will be upholstered in leather and the interior finish is of the highest quality throughout. Special provision has been made to secure proper ventilation so that with all windows closed there will be a good circulation of air. The body lines are neat and pleasing and a departure from the ordinary passenger carrying bus in this regard.

A great deal of study was given in the preparation of the specifications to devise a method of comparing bids which would secure for the City a bus combining the highest standard of workmanship with the least operating cost; in other words, to secure the best value for the money paid.

In order to secure these conditions the specifications provide "that the lowest bid will be considered to be that covering a bus which will, in the judgment of the City Engineer, show the lowest net cost of operation over 125,000 miles, and at the same time meeting the requirements of these specifications as to general design, construction, appearance, and serviceability.

"All elements affecting the ultimate cost of operation will be considered, using the bid prices and guarantees, insofar as they may apply, and arbitrary values as estimated by the City Engineer, to cover any and all elements affecting the operating costs not covered by bid prices or guarantees made in the proposal.

"In comparing bids due allowance will be made for the difference in cost of the tire equipment covered in the proposal. Other items of the equipment of accessories not affecting the reliability of service or the cost of operation and maintenance, will be reduced where practicable to an equivalent basis for the comparison of bids.

Before awarding a contract for any auto bus the Board of Public Works may require the bidder to demonstrate to the satisfaction of the Board that a chassis of the make and

model named in the proposal is capable of satisfactorily meeting the requirements and tests herein prescribed. Satisfactory completion of such preliminary test shall not relieve the Contractor of the requirements of the acceptance tests."

It will be seen from the foregoing that the object of the competitive bids was to secure a type of bus which would cost the City the least money throughout, a period of 3 or 4 years representing what might be considered as the normal life of a good bus.

Under these specifications some six bids were received. After investigating the several bids and making test runs of similar chassis manufactured by the several bidders, the City Engineer recommended that the Board of Public Works award the contract to the White Company on the counts that the bus offered by the White Company best meets the requirements of the specifications and would show the lowest net operating cost over 125,000 miles of operation, taking into consideration all elements affecting the operating cost. The contract was awarded to the White Company and the Board of Supervisors was requested to appropriate the amount of the contract price.

Protests were registered by several of the other bidders, who claimed that their bid was lower than that of the White Company. This matter was referred to the Board of Public Works and a public hearing granted to all protestants. After carefully considering points raised by the protestants and the report of the City Engineer, the Board of Public Works determined that there was no argument presented which would lead it to change its decision. This was reported back to the Board of Supervisors, who thereupon appropriated the necessary money to cover the contract price.

Subsequently the Home Industry League took up the protest of the dissatisfied bidders and employed an attorney to secure an injunction to prevent the Board of Public Works from accepting the buses being manufactured by the White Company. The application for injunction was heard by Judge Seawell and denied.

Subsequent to the determination by the Supervisors to establish a bus service across Golden Gate Park to operate in conjunction with the Municipal Railway System the Board of Harbor Commissioners requested that the City establish a bus system on the Embarcadero to extend from the Channel at the foot of Second Street around the Embarcadero and going as far north as Fisherman's Lagoon at the foot of Taylor Street. In the communication addressed to the Mayor and Board of Supervisors the Harbor Commission stated that it would provide and maintain a smooth pavement at least 30 feet wide for the use of such bus line without cost to the municipality. The matter was referred to this office for a report and a comprehensive study was made as to the probable traffic which such a bus service would be required to handle, an actual count being made by means of a circular letter of all employees of the steamship and shipping companies and other offices along the water front, together with the probable number of passengers handled in and out of the port by the said companies. Based on these studies this office reported back to the Public Utilities Committee as follows:

MOTOR BUS LINE ON THE EMBARCADERO.

January 3, 1917.

Public Utilities Committee,

Board of Supervisors,

San Francisco.

Gentlemen: In response to your request that this office report upon the establishment of a motor bus service on the Embarcadero, as proposed by the Board of State Harbor Commissioners, in their letter to the Mayor and Board of Supervisors under date of December 12, 1916, I beg to submit the following:

The Board of State Harbor Commissioners, in their letter, have suggested the establishment of a municipally operated motor bus line around the active waterfront on the Embarcadero from the Fisherman's Lagoon at the foot of Taylor Street on the north to the Channel or Third and Townsend Streets on the south, with transfer connections to the Municipal Railway System at the foot of Market Street, and have offered, without cost to the municipality, for the use of such bus line, a smooth asphalt pavement.

The need for transportation service along the Embarcadero has long been recognized and Bion J. Arnold, in his Transportation Report, recommended a street car line along the Embarcadero as one of the future desirable extensions. The cost of constructing a railroad and the difficulty of operating such a road have been such as to render its construction prohibitive. These restrictions do not apply to motor buses, which would seem to be almost ideally suited to this service, provided that there is the smooth pavement to travel on, with reasonable traffic regulations.

The round trip length of the route is 6 miles. A tentative schedule has been prepared which provides for a 5 minute headway during the rush hours, 6½ minutes during the middle of the day, and 10 minutes in the early morning and evening. There would be 123 round trips which, with the dead mileage to and from the car barn, will require approximately 800 bus miles per day. The total cost of this service, including the original investment for 9 buses (one spare being deemed necessary), depreciation, interest, administration charges, maintenance, and operating expense, would amount to \$144 per day.

A study of the amount of business which might be expected for this bus line has been made, which indicates that the receipts at this time of the year will just about meet the cost of service above mentioned, and during the months of heavy travel should show a slight margin of profit.

The small margin between revenues and operating cost would demand, for the success of the line, that it be operated under good traffic regulations and without competition. This office recommends that the motor bus service be established on the Embarcadero along its entire length at such time as the Harbor Commission shall complete the asphalt paving contemplated in their letter to your Board, provided that competition is not permitted and that reasonable traffic regulation is maintained.

Respectfully,

(Signed) M. M. O'SHAUGHNESSY

City Engineer.

The introduction of motor buses as an adjunct to the Municipal Railway System must be looked upon somewhat in the nature of an experiment, for the Municipal Railways are practically pioneers in this movement. It must be borne in mind that these motor bus extensions are not expected to be a source of revenue to the railways. On the contrary, the City must expect to operate these at some loss in an effort to provide service in thinly settled districts or districts where

car service cannot be otherwise given, the idea being that the loss in operating motor buses will be less than that incurred by constructing and operating railroad extensions in these districts at the time.

The opportunity is taken to emphasize that paragraph in my report in which the recommendation is made that where a bus service is installed on a definite route this route must be permanently established by action of the Board of Supervisors in order that the service will continue until the conditions warrant the replacement of such bus service by the construction of a line of street railway. A great deal of the objection of property owners to the installation of bus service instead of streetcar service is due to the fact that they have no assurance that this service will be permanent. Without such assurance people hesitate to buy property in these districts or, if they already own property, to build their homes thereon, as there is always a feeling that the bus service may be taken away, whereas if tracks are constructed they feel that they are assured of permanent service.

STATEMENT OF 1910 GEARY STREET BONDS

Total receipts from Bonds and Miscellaneous Sources.....	\$1,934,796.27
Expended to date.....	1,934,587.52
	<hr/>
Balance on hand.....	\$ 209.75

STATEMENT OF 1910 MARKET STREET BONDS

Total Receipts from Bonds and Miscellaneous Sources.....	\$81,843.58
Expended to date.....	77,768.67
	<hr/>
Cash balance on hand.....	\$ 4,074.91
Unsold bonds	29,000.00
	<hr/>
Balance Cash and Unsold Bonds.....	\$33,074.91

STATEMENT OF 1913 MUNICIPAL RAILWAY BONDS

EXPENDITURES 1916-1917

Church St. Railway, 18th to 22nd.....	\$ 33,976.54
Church St. Railway, 16th to 18th and 22nd to 30th.....	467.66
Concrete Poles—16th to 18th and 22nd to 30th.....	250.00
Concrete Poles—Division St., Bryant to Potrero Ave.....	420.00
Copper Rail Bonds, Church St.....	1,388.25
Electrical Conductors, Church St.....	5,847.87
Inspection of Railway Construction and Extension.....	143.35
Plans and Specifications, Church St. Railway.....	519.25
Bonding Rails for Church St.....	215.40
Bonding Crossings	447.62
Church St., 16th to Market—Narrowing Walks.....	2,517.66
Church St. Railway, 16th to Van Ness Ave and Market....	45,269.81
Electric Cables for Church St. Rwy., 16th to Van Ness Ave. and Market St.....	8,028.74
Electrical Conductors, furnishing and installing for Church St. Rwy.—16th to Van Ness and Market.....	683.55
Incidentals other than extras, Church St.....	478.24
Inspection, Church St. Railway.....	5,020.65
Machine Shop Equipment at Pipe Yard.....	81.75
Reporting proceedings—Market St. Railway Controversy	318.80
Pipe Yard Maintenance.....	839.39
Track Special Work	16,420.94
Trolley Poles, Church St. and Market.....	5,152.04
Unloading and Handling Railway Material.....	692.36
<hr/>	
Total during 1916-17.....	\$ 129,179.87
Expended prior to July 1, 1916.....	3,354,791.80
<hr/>	
Expended to date	\$3,483,971.67
Total receipts from bonds and miscellaneous sources.....	3,559,819.01
<hr/>	
Balance for future expenditures, including liabilities..\$	75,847.34

TWIN PEAKS TUNNEL

On April 5, 1917, crews working on the East and West headings of the Twin Peaks Tunnel met underground 6,000 feet from the easterly portal. When the headings met it was found that the alignment and grades of the tunnel checked to within one-half an inch.

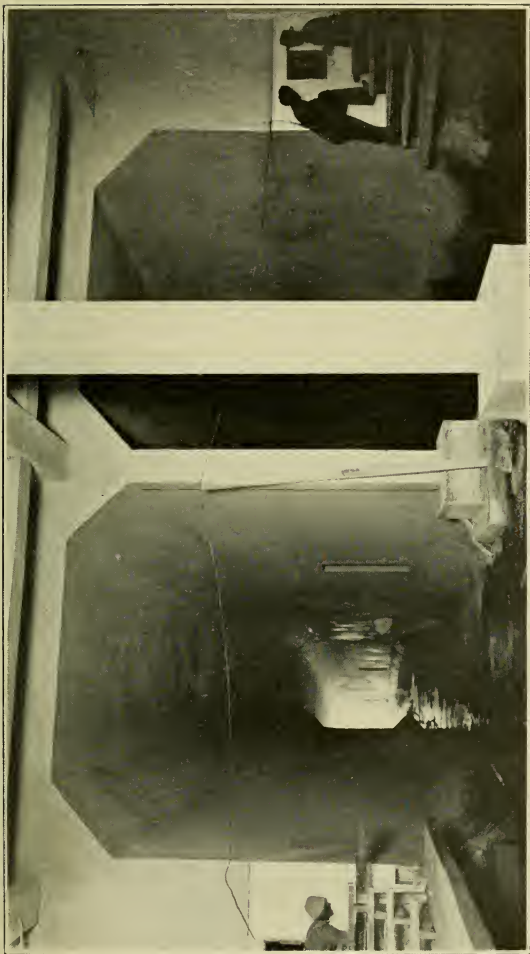
On July 14, 1917, the tunnel was finally accepted by the Mayor and city officials, with appropriate ceremonies to celebrate the completion of the work.

Construction was started on this project on November 30, 1914, and has progressed steadily, sometimes under very adverse conditions.

The material encountered between the west portal and Laguna Honda Station was sand, excepting an intrusion of chert and incipient sandstone for about 300 feet. The excavation through this portion progressed at the rate of 12 to 15 feet a day over three 8-hour shifts. Between the station and a point 200 or 300 feet beyond the shaft, the tunnel passed through water-bearing sand above a clay stratum and the progress of the excavation was much slower. The large volume of water required the constant running of several centrifugal pumps until the excavation was finished and the drains in the center of the tunnel from both ends connected up.

At the east end of the tunnel, the excavation for several hundred feet was through clay and gravel, and then passed into chert and altered sandstone. The chert was in layers with clay strata between and required the same heavy timbering as the softer material. A considerable flow of water from underground springs appeared in this section but did not hinder the work to any extent. Open joint pipe drains were carried forward beneath the footings and materially aided in keeping the tunnel dry.

After passing through the altered sandstone, a body of very hard sandstone was penetrated. This was found to be



Approach to Eureka Valley Station.

an excellent rock for use in concrete and the installation of a crushing plant was planned but the body of sandstone petered out. Serpentine was then encountered and continued for a length of 4,000 feet up to the water-bearing sand near the ventilating shaft. Throughout the serpentine, the open timbering was used and the excavation carried forward from 10 to 14 feet in 24 hours.

The following table shows the materials penetrated, methods of excavation and types of timbering and lining used throughout the tunnel:

EXCAVATION DATA

From Station	To Station	Material Penetrated	Excavation	Type of Timbering	Type of Reinforced Concrete
0+85	5+63	Sand West end	In open cut	None	22" arch section
5+63	30+55	Sand West end	In tunnel from west	Solid	22" arch section
30+55	30+83	Sand West end	In open cut	Piling and bracing	22" arch section
30+83	33+83	Sand West end	In open cut and trenching	Piling and bracing	Station arch section
33+83	44+69	Water-bearing sand	In tunnel from west	Solid	22" arch section
44+69	46+37	Water-bearing sand over clay	In tunnel from shaft	Solid	22" arch section
46+37	46+57	Water-bearing sand over clay	As part of shaft	Spiling and walings	Special arch shaft sub-structure
46+57	52+00	Water-bearing sand, clay, sandstone and shale	In tunnel from shaft	Solid	22" arch section
52+00	54+00	Serpentine	In tunnel from west	Solid	22" arch section
54+00	59+20	Serpentine	In tunnel from west	Solid arch spaced posts	18" arch section
59+20	87+00	Serpentine	In tunnel from west	Solid arch spaced posts	18" arch section
87+00	89+60	Sandstone	In tunnel from west	Solid arch spaced posts	18" arch section
89+60	97+15	Chert, clay and gravel	In tunnel from west	Solid	22" arch section
97+15	98+64	Sandy clay and gravel (water course)	In open cut	Piling and bracing	22" arch section
98+64	100+44	Sandy clay and gravel (water course)	In open cut	Piling and bracing	22" arch section—taper
100+44	100+74	Sandy clay and gravel (water course)	In open cut	Piling and bracing	22" arch section—extra width
100+74	103+00	Sandy clay and gravel (water course)	In open cut	Piling and bracing	Double tube, flat top
103+00	111+45	Sandy clay and gravel (water course)	In open cut	None	Double tube, flat top
111+45	114+45	Sandy clay and gravel (water course)	In open cut	None	Eureka Valley Sta. flat top with steel frame
114+45	117+41	Sandy clay and gravel (water course)	In open cut	None	Double tube, flat top
117+41	120+00	Sandy clay and gravel (water course)	In open cut	None	Portal and approach walls



Eureka Valley Station.

PROGRESS DATES

Open Cut West—Station 0+85—Station 5+63:

Dec. 7, 1914—Excavation started;

March 12, 1915—Excavation completed.

Tunnel Excavation—Westerly Section:

May 24, 1915—Excavation started Station 5+63;

Sept. 3, 1915—Bottom drift started, Station 12+45;

Feb. 25, 1916—Bottom drift reached Laguna Honda Station excavation, Station 30+83;

May 13, 1916—Excavation and timber reached Laguna Honda Station.

Laguna Honda Station (sub surface structure):

March 15, 1915—Excavation started;

April 7, 1916—Concrete (except invert lining) completed.

Tunnel and Shaft Excavation:

June 2, 1915—Excavation of shaft started—Station 46+47;

Oct. 16, 1916—Bottom drift west from shaft started;

July 22, 1916—Bottom drift west from shaft connected up with drift from west—Station 42+31;

Nov. 18, 1916—Timbering west from shaft connected up with timber from west—Station 45+08;

June 22, 1916—Bottom drift east from shaft started;

Aug. 5, 1916—Top drift east from shaft started.

Open Cut East—Station 97+15—Station 120+00:

Nov. 30, 1914—Changes in street alignment and sewers, etc., started;

Jan. 5, 1915—Excavation of approach started;

Dec., 1915—Open excavation completed.

Tunnel Excavation—Easterly Section:

Jan. 8, 1916—Tunnel excavation started—Station 97+15;

April 5, 1917—Top drifts holed through—Station 59+09.

May 31, 1917—Bench and segments connected—Station 59+47;

July 2, 1917—Concrete lining completed.

A daily flow of over 200,000 gallons of water was encountered during the tunnel construction. To collect this supply and furnish the Relief Home with a water supply a collecting chamber was constructed by driving a drift southerly at right angles to the tunnel line beneath the Relief Home, for a distance of 130 feet. This chamber was approximately 5 feet by 7 feet in size, in a sand formation near the contact with the clay deposits. It was filled in alternate sec-

tions with porous tile and gravel, with open joint drains laid on the floor to a basin near the tunnel. A well was also sunk near the air shaft to connect with a sump at this point and a pump installed to raise the water to the tanks of the Relief Home.

The principal features of the Twin Peaks Tunnel are summarized as follows:

LENGTH:	12,000 ft. (2.27 miles).			
	Portion in tunnel, 8,800 ft.			
	Portion in cut and cover, 3,200 ft.			
DISTRICT	West of Twin Peaks Ridge, 4,153 acres, assessed			
BENEFITTED:	\$3,398,973.			
	East of Twin Peaks Ridge, 660 acres assessed			
	\$595,316.			
SHAPE OF	Width, 25 ft.			
SECTION:	Height, Total 25 ft.			
	Net clearance above rail, 15 ft.			
	Thickness of	Double Tube Subway Sec- tion (1365')	Section in Soft Earth (5903')	Section in Soft Rock (3556')
	Ceiling slabs	18"	.	.
	Arch		22"	18"
	Walls	21"		
	Walls at spring..		33"	33"
	Invert	20"	18"	None
GRADES AND	Maximum grade of tunnel, 3 per cent.			
CURVES:	Sharpest curve, radius of 861 ft.			
ELEVATIONS:	East portal, 130 ft.			
	Laguna Honda Station, 372 ft. at 72 ft. below ground surface.			
	West portal., 342 ft.			
	Elevation of ridge penetrated: North Peak 904.25 ft., South Peak 910.97 ft.			
	3½ minutes to pass through tunnel at 40 miles per hour.			
TIME:	Working schedule not to exceed 6 minutes.			
	From Second and Market Streets to East Portal, 16 minutes.			
	From Second and Market Streets to Sloat Boulevard, 24 minutes.			
	Present schedule, 44 minutes.			
	Saving in time through tunnel, 20 minutes.			



Laguna Honda Station in Tunnel.

COST	Lands	\$ 600,000	Paid for by Twin Peaks
ESTIMATE:	Tunnel const...	3,400,000	Tunnel Assessment Dists.
	Tracks	250,000	Paid for by City.
	Total	\$4,250,000	

CONSTRUCTION WORK: Reinforced concrete lined throughout.
Electric power used on all construction work.
Concrete mixed and transported 3,900 ft by compressed air.

CONTRACT: Awarded November 2, 1914.
Signed, November 2, 1914.
Work started, November 30, 1914.
Work completed, July 14, 1917.
Time allowed to complete, 1,000 days.
Time required to complete, 985 days.

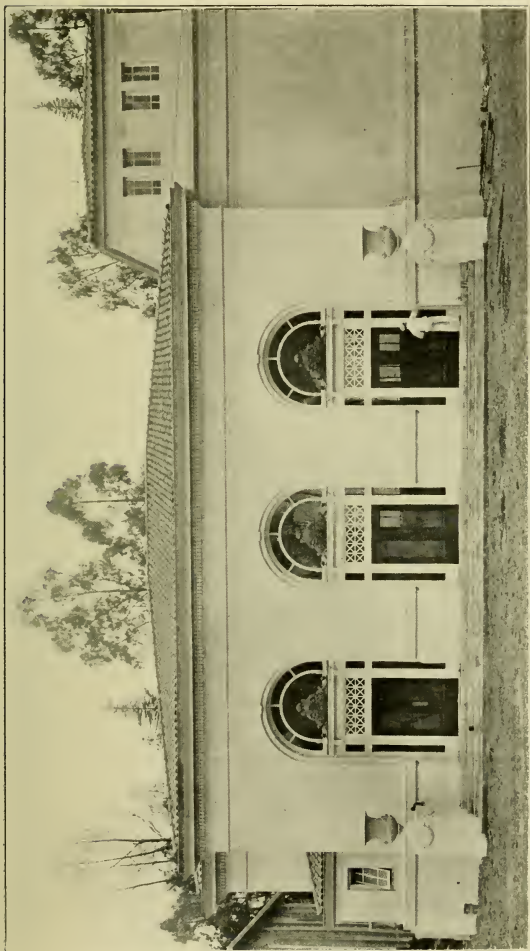
ENGINEERING: Line met by one-eighth of an inch.
Levels checked by three-eighths of an inch.

QUANTITIES: Excavation 530,000 cu. yds.
Cement 120,323 bbls.
Sand 39,458 cu. yds.
Gravel 94,245 cu. yds.
Reinforcing steel 2,850 tons
Timber 11,000 M ft.

GEOLOGY: Open cut and west tunnel section, 5,000 ft. in sand,
of which 1,000 ft. was saturated.
Open cut east end, dry sandy clay, 2,300 ft.
Tunnel.—Chert, sandstone, and 3,500 ft. serpentine.

SUBWAY STATIONS: (1) Eureka Valley Station, in the vicinity of Seventeenth and Castro Streets, the easterly portal, is a structural steel frame encased in concrete, 300 feet long by 54 feet wide, connecting with the street surface.
(2) Laguna Honda Station is an expanded portion of the tunnel, 300 ft. long by 44 ft. wide, with 22 ft. clearance above rails in center. Tricentric arch—lining 3 ft. thick, with heavy concrete invert.

VENTILATING STATIONS: Eighteenth and Hattie Streets and at the Relief Home tract.
Relief Home Tract ventilating shaft connected with tunnel by a reinforced concrete lined shaft 13 ft. in diameter and 110 ft. high.



Laguna Honda Surface Station.

VENTILATING DUCT: Ventilating duct in tunnel is between a suspended reinforced ceiling slab at the spring line and the intrados of the arch. The air passes from this duct into the tunnel through louvres in the ceiling slab spaced at 50 ft. intervals.

CONTRACTOR: R. C. Storrie and R. B. Muir.

ENGINEER: M. M. O'Shaughnessy, M. Am. Soc. C. E.

SEWER SYSTEM

The construction program for main sewer extensions as outlined in the last annual report was strictly adhered to, resulting in the construction of the following mains:

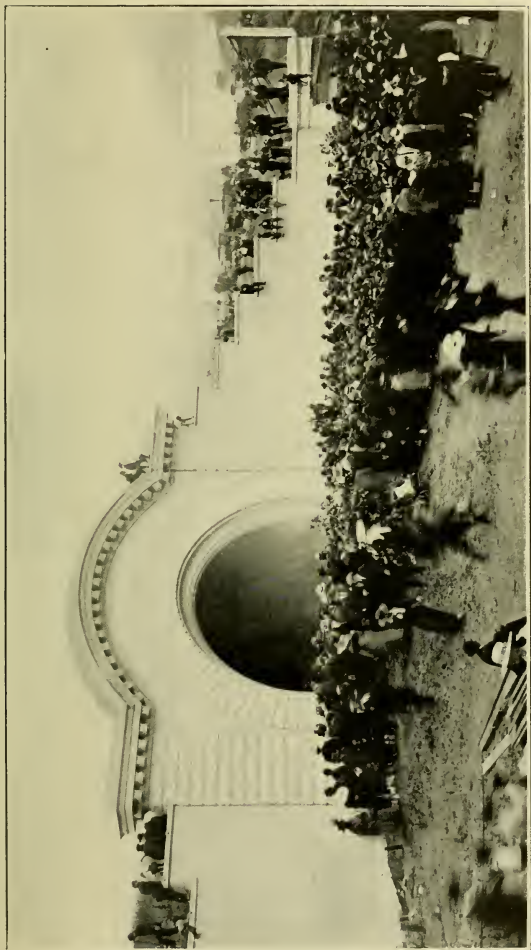
Orizaba and Stanley Streets sewers, providing for an outlet for the west side of the Ocean View District, extending northerly along Orizaba Street from Palmetto Avenue to Stanley Street; thence westerly along Stanley Street to the Spring Valley Water Company's property; thence northerly to join the existing sewer west of the Ingleside Terrace.

La Playa and Great Highway sewer from Noriega Street to Lincoln Way where connection was made to the existing 9'x11' main in 48th Avenue and Golden Gate Park.

Felton Street and Somerset Street sewer in Felton Street from University to Somerset and in Somerset from Felton to Wayland.

Glen Park sewer extension of existing sewer from Burnside Street to a point 500 feet westerly therefrom.

The Stanley Street sewer was constructed by D. L. Bienfeld for \$29,088.97. That portion which lies in the Spring Valley Water Company's property consists of 16" and 18" cast iron pipe. Where the line crosses a deep gulch the sewer is supported on a wooden trestle 330 feet long whose highest bent is 43 feet. The grade summit in Ocean View directs the drainage easterly and westerly, the former eventually reaches the outlet at the foot of Sansome Street via the North Point Main and the latter enters the Ocean at the North end of 48th Avenue produced after traversing the Mile Rock Tunnel under the Sutro Heights.



South Portal—Twin Peaks Tunnel on Day of Dedication.

The Tibbitts Pacific Construction Co. constructed the Felton and Somerset Streets sewers at a cost to the City of \$19,150.16. This work consisted of 2,200 feet of standard reinforced concrete egg-shaped sewer of the smaller sizes and 900 feet of 21" ironstone pipe sewer and affords drainage to the University Mound District via the Visitacion Valley Outfall. The excavation on this job was in a dry clayey sand and was performed by an Austin trencher.

Karl Ehrhart was the successful bidder for the Glen Park Sewer Extension consisting of 500' of 5' circular reinforced concrete sewer costing \$5,955.41.

Preliminary to the contemplated improvement by paving, nearly a mile of reinforced concrete main sewers were constructed in La Playa and the Great Highway by the Clinton Construction Co. at a cost of \$36,786.80. This work penetrating a saturated formation in an 11' cut required heavy lagging and pumping. The excavation was removed by buckets and derricks and the backfill made with derrick.

The Oakdale Avenue sewer between San Bruno Avenue and Selby Street, consisting of a reinforced concrete sewer on piles was completed during the last year by Karl Ehrhart at a cost of \$16,031.50.

The sewers and appurtenances in course of construction in the westerly slope of the Twin Peaks Ridge designed to provide drainage to the residential tracts around the west portal of the Twin Peaks Tunnel are practically completed. The westerly portion of the work consists of 230 lineal feet of 5'3" circular reinforced concrete sewer in tunnel under 19th Avenue just north of Sloat Boulevard. The westerly termination of this tunnel is shortly to be connected to the existing sewer in Sloat Boulevard by the construction of a reinforced concrete sewer in the intervening five blocks.

PROPOSED SEWERS

Lake Street—22nd to Presidio, along Lobos Creek, 150 feet, at an estimated cost of.....	\$22,000.00
Trocadero—19th to 24th Avenues, at an estimated cost of....	30,000.00
Guttenberg—Mission to first angle above Morse, at an esti- mated cost of.....	5,000.00
Outlet for Williams Ave. Sewer—In Phelps Street, at an estimated cost of.....	5,000.00
Commercial Street Pumping Station—At an estimated cost of	7,000.00

STATEMENT OF 1904 SEWER BONDS
EXPENDED DURING 1916-17

Alta Street, Filbert Street, Greenwich Street, Sansome to Montgomery	\$ 1,022.00
Lake Geneva District Damage.....	3,000.00
Stanley and Orizaba Sewers.....	19,337.66
Fulton St., Somerset to University Ave.; Somerset St., Wayland to Felton.....	1,000.00
	<hr/>
	\$ 24,359.66
Prior to July 1, 1916.....	1,979,236.88
	<hr/>
Total to date.....	\$2,003,596.54
Total receipts from Bonds and various sources (including \$1500 added for balance on Stanley St., General Fund	2,016,885.76
	<hr/>
For future expenditures including that due on present contracts	\$ 13,289.22

STATEMENT OF 1908 SEWER BONDS

Plans and specifications.....	\$ 1,114.57
Expenditures prior to July 1, 1916.....	4,338,293.22
	<hr/>
Total expended to date.....	\$4,339,407.79
Total receipts from bond proceeds and miscellaneous sources	4,340,123.13
	<hr/>
Balance for future expenditures.....	\$ 715.34

AUXILIARY WATER SUPPLY

The work of constructing extensions to the high pressure use Auxiliary Water Supply System mains during the last twelve months was confined to the laying of mains in the Telegraph Hill District; in Pine Street between Powell and Jones Street; and in First Street between Folsom and Harrison Streets, all under the one contract performed by E. M. Whitlock at a cost of \$10,147.31.

The many frame dwellings on the steep slopes of Telegraph Hill present a great fire hazard. The extension of the high pressure mains up these slopes provide an added protection with an attendant reduction in insurance rates.

The rock formation in this district made the excavation work costly.

The other two sections of the contract accomplished similar reductions in the insurance rates by greatly diminishing the fire hazard.

No definite program of future extensions has been outlined because of lack of available funds with which to make the installation. The bond account is virtually exhausted and the small balance remaining will be expended for changes in the existing system.

STATEMENT OF 1908 FIRE PROTECTION BONDS EXPENDED 1916-1917

Burnett and Clarendon.....	\$ 723.00
Hauling and Laying—Telegraph Hill, Pine St., First St....	11,858.70
Watchman, Engineering and Maintenance, Pipe Yard.....	3,208.99
Plans and specifications.....	361.70
Side Sewer Refund.....	140.00
	<hr/>
	\$ 16,292.39
Expended prior to July 1, 1916.....	5,735,839.35
	<hr/>
Expended to date	\$5,752,131.74
Total Receipts from Bonds and Miscellaneous Sources.....	5,762,507.25
	<hr/>
Balance for future expenditures.....	\$ 10,375.51

SURVEYS

During the fiscal year a total of 1,838 orders for surveys were received at the public counter. Of these, 46 were for lot surveys and 1,792 were for surveys for public improvements and in answer to petitions or complaints. They include approximately as follows: 5,514 blocks and crossings, a total length of 2,591,580 lineal feet, or 490 miles.

Precise levels were run, covering about 180 miles; total number of bench marks rechecked and established, 2,601.

Approximately totals are as follows:

7,359 blocks and crossings

3,537,600 lineal feet or 670 miles.

Fees collected and turned over to the City Treasurer, \$24,712.

NUMBER OF MAPS ON FILE JUNE 30, 1917

Subject	Tracings	Negatives	Originals	Duplicates	Total
1338	1738	1568	1132	1527	7303

Following is a detailed description of the work performed:

SURVEYS		
Made for		Number of Surveys
Public contracts	171	
Private contracts	306	
Resurveys for contractors (lost points).....	330	
Examinations of Public Improvements.....	481	
Street Repair Department.....	70	
Sewer Repair Department.....	3	
Superintendent of Public Buildings.....	10	
Public Library	1	
Division of Sewers.....	160	
Division of Grades.....	34	
Division of Surveys.....	160	
State Engineering Department.....	5	
Bureau of Engineering.....	25	
Board of Public Works Commission.....	36	1,792

LOT SURVEYS

Private Owners	34	
State Engineering Department.....	1	
City Architect	6	
Fire Department	1	
Public Library	2	
Superintendent Public Buildings.....	1	
Division of Streets and Sewers.....	1	46
Total		1,838

For the fiscal year ending June 30, 1917, precise levels have been run in all portions of the City and Bench Marks have been established, corrected or reconstructed including City Monuments over the Twin Peaks Boulevard, Corbett Avenue, Lincoln Way, Great Highway, Sloat Boulevard, Third Street for its entire length, almost all of the Sunset District and all streets in the vicinity of the Exposition Grounds.

Precise levels have been run and bench marks established as follows:

Bench Marks, 50 Varas	80
Bench Marks, Mission and Horners Ad.....	629
Bench Marks, 100 Varas	210
Bench Marks, Western Addition	220
Bench Marks, Potrero and South San Francisco..	630
Bench Marks, Sunset	162
Bench Marks, Other Districts	680
Total Bench Marks.....	2601
Total Miles of Levels.....	180

NEW SUBDIVISIONS APPROVED AND FILED IN THE HALL OF RECORDS

Title	No. of Streets	Filed in Hall of Records
Seacliff Subdivision No. 2.....	2	July 6, 1916
Merritt Terrace	3	August 11, 1916
Claremont Court, Parcel No. 2 (Blocks 2887, 2888)	1	October 10, 1916
C. A. Hawkins Property.....	2	January 3, 1917
St. Francis Wood, Extension No. 1.....	3	February 15, 1917
Relief Home Tract.....	1	February 15, 1917
Pacific Terrace No. 2.....	2	February 26, 1917
Westwood Park	7	March 20, 1917
Claremont Court, Parcel No. 2 (Blocks 2975, 2988, 2989)	2	April 14, 1917
St. Francis Wood, Extension No. 2.....	2	May 1, 1917

FEES RECEIVED FOR SURVEYS

	For Public Improvements	For Private Improvements
1916		
July	\$ 2,091.25	\$ 50.00
August	2,314.50	50.00
September	1,749.00	25.00
October	1,930.00	145.00
November	1,811.50	109.00
December	2,088.00	95.00
1917		
January	2,069.50	75.00
February	2,564.25	30.00
March	2,008.75	75.00
April	1,928.25	75.00
May	2,187.00	90.00
June	1,151.00	.....
	<hr/>	<hr/>
	\$23,893.00	\$819.00
Grand total	\$24,712.00	

MAPS PREPARED AND FILED WITH THE RECORDER FOR THE
CLOSING, OPENING AND WIDENING OF THE FOLLOWING
STREETS JULY 1, 1916 TO JUNE 30, 1917 (Inclusive)

Date Filed With Recorder	Name	No. of Streets	Resolution No.	Approval of B.P.W.
Sept. 19, 1916	Bernal Ave and Shotwell St. with Bessie St. (land deeded for public stairway)	1	48072 (2nd series)	Sept. 13, 1916
Oct. 5, 1916	Danvers St., declared pub- lic street	1	47631 (2nd series)	Aug. 18, 1916
Oct. 25, 1916	Edna St., Joost to sunny- side (opening new street)	1	48532 (2nd series)	Oct. 9, 1916
Nov. 22, 1916	Hidalgo Terrace (open- ing new street)	1	48857 (2nd series)	Oct. 25, 1916
March 16, 1916	Guttenberg, Florentine, Watt Ave. (widening and extension)	1	48657 (2nd series)	Oct. 13, 1916
March 27, 1917	Hamburg St. (widening Flood Ave.)	1	46815 (new series)	July 5, 1916
April 27, 1917	Judson Ave. (extension), Phelan Ave. (extension)	1	43782 (new series)	Feb. 9, 1917
May 24, 1917	St. Mary's Ave. (exten- sion)	1	13540 (new series)	Oct. 30, 1916

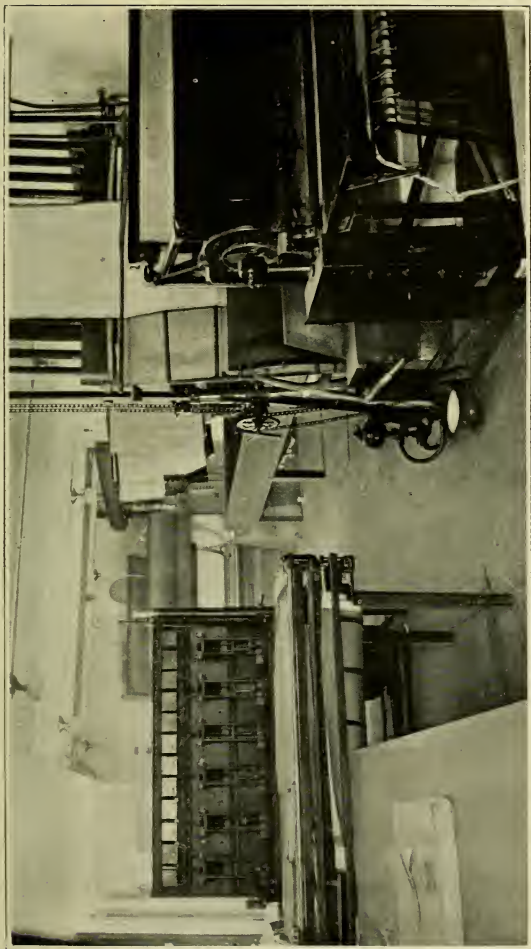
TESTING LABORATORY

During the fiscal year 1916-1917 the Testing Laboratory made 6004 tests on various materials at a cost, inclusive of salaries and supplies, of \$5,529.40. These tests are given in detail by month and show the routine inspections of materials used in the construction of pavements, sewers, tunnels and buildings.

The Supplies Committee of the Board of Supervisors submitted 210 samples of paints and lubricating oils to the Laboratory for a report on quality. It is upon this report that the contracts for the yearly supply of these commodities are awarded.

The inspection of concrete paving base has been carried on with the aid of Laboratory analysis with a marked increase in the quality of the resulting concrete. This analysis includes the determination of cement and sand ratio, an analysis widely considered impossible but which has, by continued research in the Testing Laboratory, been perfected so that accurate results are obtained in a remarkably short time.

Besides the above, the Testing Laboratory has carried on investigations on asphalt pavements an account of which, as far as they have progressed, is appended hereto.



Blue Print Department.

REPORT OF TESTING LABORATORY SHOWING CHARACTER OF MATERIALS AND THE TESTS MADE
FISCAL YEAR 1916-17

No.	Material	Tests Made	1916						1917						Total
			July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	
1	Asphaltum.....	Penetration.....	62	60	45	59	40	61	31	20	61	36	50	41	572
2	Asphalt Surface.....	Analysis.....	140	128	104	141	188	202	205	204	154	88	144	101	1,801
3	Brick, Paving.....	Rattler.....	9	3	14	15	8	8	11	8	6	4	5	7	98
4	Bronze.....	Tension.....	36	32	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	68
5	Cast Iron.....	Cross Bend.....	32	32	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	64
6	Cement.....	Strength, etc.....	200	375	110	145	125	205	200	220	210	150	90	15	2,105
7	Concrete.....	Compression.....	5	4	.....	.....	8	8	2	5	6	19	.....	14	71
8	Galv. Iron.....	Analysis.....	.....	.....	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	15
9	Gasoline.....	Analysis.....	.....	.....	.....	.....	.....	.....	.....	6	12	.....	.....	.....	18
10	Lime Hydrate.....	Analysis.....	1	4	5	4	2	3	8	2	5	2	2	1	39
11	Lub. Oils.....	Physical.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	60	.....	62
12	Mortar.....	Analysis.....	4	21	9	12	25	10	17	12	24	13	21	1	169
13	Paints.....	Analysis.....	.....	.....	4	5	3	.....	1	.....	.....	.....	2	20	35
14	Rock.....	Grading.....	8	8	8	.....	12	12	5	1	4	15	1	.....	74
15	Roofing Felt.....	Analysis.....	2	.....	.....	4	1	2	.....	4	2	11	6	.....	32
16	Roofing Tin.....	Analysis.....	21	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	24
17	Sand.....	Grading.....	6	8	10	8	6	2	2	4	7	20	4	1	78
18	Sewer Pipe.....	Compression.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	28	.....	28
19	Soaps.....	Analysis.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15	.....	15
20	Steel.....	Bending.....	28	48	20	15	29	74	23	18	11	16	12	2	296
21	Steel.....	Tension.....	28	48	18	16	35	65	27	18	14	15	23	.....	304
22	Water, Boiler.....	Analysis.....	2	.....	.....	2	1	1	.....	2	.....	1	.....	8	8
23	Wire.....	Tension.....	.....	.....	.....	.....	.....	1	.....	.....	3	1	.....	20	25
			587	771	392	429	182	654	535	526	516	391	474	226	6,004

PHOTOGRAPHIC AND BLUE PRINT REPORT—FISCAL YEAR 1916-17

	Blue Prints	Square Feet		Prints			Cloth		Photostat	
		Blue Line	Black Line	Negative	Blue	Black	Blue	Black	10 1/2 x 15	15 x 21
City Engineer	99,580	127,896	7282	6765	3268	254	3268	254	7068	5194
City Architect	56,618	9,212	99	1126	3381	.....	3381	.....	59	17
City Attorney	978	691	558	78	72	.....	72	.....	606	382
Fire Department	9,060	1,859	56	40	.....	.....	.....	.....	315	93
Board of Health .....	.....	900	480	20	.....	.....	.....	.....	25	4125
Assessor	72	.....	.....	.....	.....	.....	.....	.....	16	167
Auditor	120	.....	.....	.....	.....	.....	.....	.....	272	322
Board of Supervisors .....	.....	.....	.....	.....	.....	.....	.....	.....	29	24
Civil Service Commission .....	.....	.....	.....	.....	.....	.....	.....	.....	114	42
Street Repair Department .....	.....	1,368	.....	21	.....	.....	.....	.....	.....	20
Board of Works .....	.....	.....	.....	.....	.....	.....	.....	.....	471	2050
Mayor's Office .....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....
Department of Electricity .....	.....	72	.....	.....	.....	.....	.....	.....	.....	.....
	166,428	141,998	8475	8050	6721	254	6721	254	8977	12436

PHOTOGRAPHIC AND BLUE PRINT REPORT—FISCAL YEAR 1916-17—Continued

	Photographs					Prints					Slides				
	Negatives														
	5x7	8x10	3 1/4 x 5 1/2	8"x3'	4x6	5x7	8x10	8 1/2 x 11	14x17	16x20	20x30	8'x3'	6'x30"	3 1/4 x 4 1/2	
City Engineer	127	65	...	6	1649	3422	856	...	14	17	2	31	3	20	
City Architect	3	31	...	...	...	39	133	...	...	...	...	5	...	...
City Attorney	26	8	...	...	...	76	13	...	...	...	...	3	...	...
Fire Department	...	...	...	...	...	...	...	...	...	...	...	1	...	...
Board of Health	71	11	524	...	516	903	16	...	...	...	...	...	...	...
Assessor	...	...	...	...	...	...	8	...	...	...	...	...	...	...
Auditor	...	...	...	...	...	28	...	...	...	...	...	2	...	...
Board of Supervisors	...	...	...	...	...	...	3	...	...	2	...	...	...	...
Street Repair Dept	1	72	...	...	...	102	...	223	...	...	...	...	...	...
Sealer Weights & Measures	...	4	...	...	...	...	10	...	...	...	...	...	...	...
City Treasurer	...	2	...	...	...	...	16	...	...	...	...	...	...	...
Board of Works	4	...	...	...	...	130	26	...	...	...	4	2	...	...
Mayor's Office	...	...	...	...	...	34	13	...	27	...	...	13	...	...
Street Cleaning Dept	...	...	...	...	...	20	...	...	14	...	...	...	...	...
	538	193	524	6	2165	4754	1094	223	55	19	6	57	3	20	

GARBAGE DISPOSAL

In the annual report for the fiscal year 1915-1916 was given a brief account of the several proposals that had been made to the Board of Supervisors by different agents and promoters for furnishing or operating various sorts of plants and methods for the destruction or disposal of refuse. None of these proposals were recommended for adoption by the City Engineer.

During the first two or three months of the present fiscal year there were frequent meetings of the Board of Supervisors and of the Health Committee thereof at which this question was discussed in all of its ramifications.

Fred P. Smith, for himself and his associates, under date of August 30th, 1916, filed a communication with the Board in which it was proposed that he and his company should take over and operate the plant of the Sanitary Reduction Company—assuming that the City would complete the purchase of the property by payment of the \$50,000 balance on total price of \$400,000.00.

Mr. Smith offered, 1st, to put up \$22,000.00 cash as a surety of fulfillment of their undertaking;

2nd. To pay to the City \$22,000.00 annually for the privilege of operating the plant as it stands;

3rd. To establish an eight hour day for labor and three dollars minimum wage for employees; and

4th. To improve the sanitary conditions about the plant and entirely remodel and modernize the same without cost to the City in consideration of certain stated periods of operation, referring to former proposals and definite periods for such a franchise as might be granted.

At subsequent meetings of the Committee and the Board of Supervisors, these proposals were considered and discussed, and the former proposal of Richard Schmidt also came in for further consideration. Schmidt advocated a process of disposal by burial or "sanitary fill" similar to the method used in Seattle, Washington.

On September 1, 1916, the Board of Supervisors asked the Board of Public Works for a

“Report on the practicability of remodeling the present reduction plant to make it work satisfactorily and properly incinerate the City’s garbage and refuse. Should it be practicable to remodel the plant, how long would it require to prepare specifications for the work?”

In reply to this, the City Engineer submitted a report upon the different proposals of Mr. Smith, and commended in part, as follows:

“Regarding your inquiry as to the practicability of remodeling the plant now in operation and how long a time would be required to prepare specifications for the work—there does not appear to be any good reason why this plant could not be remodeled—it would be quite practicable and the present method of disposal could be continued during the rebuilding period. Upon the payment to the Sanitary Reduction Works of the unpaid balance of \$50,000 on the total sale price of \$400,000 according to the terms of agreement dated 8th March, 1909, the Reduction Plant becomes the property of the City.

“The municipality may then operate the plant, if it so decided, or may lease it or let it to the highest bidder to be run as a private venture, but according to the opinion of the City Attorney, addressed to the Board of Supervisors under date of 27th September, 1916, it will be necessary to advertise for bids for taking over the plant and conducting it according to the requirements of a carefully prepared specification.

“Such specification should contain definite statements of the requirements of operation for the whole plant from the time refuse is received over the scales until the ash and clinker are delivered to the railroad switch at the yard limits.

“Specifications for proposals covering any or all of the propositions submitted by Mr. Smith and as may be required by your Board, should not be rushed. Every item must be thoroughly considered and I would not care to provide such specifications within less than four months’ time. There should be an available appropriation of about \$1,000 to cover the cost of preparing same, if your Board orders their preparation.”

No appropriation was made, and after some further discussion the Supervisors invited proposals for the Disposal of Garbage. Bids were received on November 20, 1916, and it was specified that

“Each bidder shall furnish detailed plans which he proposes to use in such garbage disposal and state fully the terms, conditions and guarantees attached thereto. . . . A certified check or cash deposit in the sum of \$10,000.00 . . . shall accompany each proposal, conditioned that the bidder will enter into or contract for the disposal of garbage according to the terms of his proposal with such guarantees for its faithful performance as the Supervisors may require, within ten days after the same shall be awarded to him, otherwise such check or deposit shall be retained and become the property of the City and County of San Francisco.”

In response to this announcement there were two bids presented. One from Richard Schmidt who proposed to receive all garbage and refuse as collected by the scavengers, accept its delivery from their wagons, and dispose of it by dumping such garbage and refuse on, and using it for filling in, low lands in the City or other places satisfactory to the proper authorities thereof.

As garbage was dumped it was to be treated by a process that would prevent it from being a harbor or breeding place for flies, rats or other vermin and then covered with at least one foot of earth or rock. The proposal offered a guarantee that the whole process of disposal and the fills when made would be sanitary and without noxious odors, free from insects and vermin and wholly satisfactory to the officials of the City.

The term of contract asked for was five years, subject to immediate cancellation by the City if the operation and conduct of the work should not be entirely satisfactory to proper authorities.

This proposal was based on charging scavengers the present ordinance rate of sixty cents per ton for refuse delivered, and offered to pay the City twenty cents per ton for all garbage and refuse delivered by scavengers for the first twelve months of the life of the contract and twenty-five cents per ton for all garbage and refuse delivered for the rest of the life of the contract.

Richard Schmidt's proposal also offered to permit the diversion of any quantity up to 200 tons daily of the as-

sumed daily delivery of 500 tons of refuse, for the purpose of experimenting with incineration or garbage disposal methods other than dumping and filling.

It was also stated that the proposed franchise privilege should be subject to any fair and equitable conditions which the City desired to incorporate into the contract.

The second proposal was from A. B. Moffitt, L. G. Bonzagni and Fred P. Smith, who offered to receive the garbage and refuse as delivered by scavengers and dispose of it by dumping and filling in low ground in the Islais Creek District either east or west of the Southern Pacific Viaduct or upon both sides of same subject to approval, and for a period of from eighteen months to twenty years as may be approved and awarded by the City, during which time of the life of the contract the contractors would be authorized to charge scavengers sixty cents per ton for all refuse delivered, out of which they would pay to the City twenty-two and one-half cents per ton, or \$35,100.00 per annum.

This was proposed as a more or less temporary method of disposal, for there was an alternative in the proposal consisting of offer to establish receiving station for refuse on Islais Creek, to which scavengers would deliver all collections and from which refuse would be removed by transporting to marsh lands under control of proponents in Marin, Contra Costa or Alameda Counties where disposal would be made in a manner satisfactory to the Health authorities having jurisdiction of such sites.

For the exclusive privilege of disposing of the garbage and refuse from San Francisco in this manner—by transportation out of the City—Smith and his associates offered to pay, for a contract term of ten years, or longer as the City would decide, thirteen cents per ton of refuse and garbage delivered, or the sum of \$20,000 per annum, as the City may elect.

The process of disposal proposed by Smith, et al., was to dump the refuse and cover the top and face of each day's dump with a double thickness of tar or roofing paper and all

laps and joints sealed with tar or asphalt compound, forming a gas-tight covering for each day's deposit.

On December 4, 1916, three members of the Health Committee submitted to the Board of Supervisors three alternative recommendations as follows:

First. That the present plant operated by the Sanitary Reduction Co. be acquired by the City by paying to the Company the balance of \$50,000 on the purchase price of \$400,000—that it be renewed and altered in such manner that the smoke and other nuisance features would be abated, and that it be operated as a municipal plant in such manner that it would be a source of revenue to the City.

Second. That the Destructor be shut down and contracts for refuse disposal be awarded to Richard Schmidt on his proposal for sanitary fill.

Third. That the Destructor be shut down and contracts for refuse disposal be awarded to Richard Schmidt and Fred P. Smith—the two bidders—and that the total tonnage be divided between them.

These recommendations were discussed by the Board without conclusion and on January 8, 1917, Fred P. Smith's tender and check were withdrawn. Subsequent discussions were held at several special meetings of the Board and at the meeting of April 16, 1917, it was decided to reject the bid of Schmidt and return his deposit check.

At that meeting it was also decided that a committee of five should be appointed, whose duty should be to consider the whole question of refuse disposal and submit report and recommendation in due course.

On May 7, 1917, the Mayor appointed the following committee: Supervisors Andrew J. Gallagher, Chairman; M. M. O'Shaughnessy, City Engineer; Wm. C. Hassler, M. D., Health Officer, and Supervisors Edward I. Wolfe and Joseph Mulvihill.

In the meantime—on the 5th of December, 1916—the action of The Destructor Co.—Power Specialty Co., Managers—against the City, was begun in Department No. 2 of the Circuit Court, Judge William C. Van Fleet, presiding. This action was for the recovery of final payments on the

contract entered into by and between the City and the Destructor Co., under date of December 19, 1910. The items of the claims against the City were for the supply and erection of an Incineration plant in Islais Creek District and the partial supply of material for a second plant in North Beach District together with the estimated profits the contractor would have made on the latter plant had he been permitted by the City to complete it.

It is of interest to note here that when the City was preparing the contract specifications in 1909, Rudolph Hering of New York, was engaged to assist in the preparation of the specifications and to frame the guarantees. These latter were given special consideration and emphasis with reference to the conditions of locations and operation of both plants. They were intended, and supposed, to represent the actual results to be attained.

Rudolph Hering appeared in the trial as one of the Destructor Company's principal witnesses, as opposed to the City, and his testimony illustrated the highly theoretical value of so-called incineration experts, as well as the futility of trying to get such practical results as were supposed to have been guaranteed.

The whole attitude of the Destructor Company during the trial was that they had built a plant which was an expression of the latest and best state of the art of incineration and it performed its work as well, and as closely in accordance with the guarantees, as could reasonably be expected.

On January 17, 1917, the jury rendered a verdict in favor of the Destructor Company for approximately \$185,000 including interest at 7% upon the amounts claimed for the period subsequent to date of claims and up to date of verdict. The City Attorney's office has since prepared an appeal.

This whole question of Refuse and Garbage Disposal is still before the City. The Committee of five has met and formed a program for further investigation of this very important subject. The question is too complex to be disposed

of in any off-hand manner and does not lend itself to regulation by any so-called standard method such as is established in so many city utilities like water supply, street railroads, sewers, etc. It is a problem that must be worked out according to local conditions and with due regard to the many details involved.

It must also be considered with reference to the policy of conservation of all values in so-called wastes that is being so strongly urged by the Food Control Commission at Washington, with which the Bureau of Engineering is now co-operating in garbage disposal investigations.

HETCH HETCHY WATER SUPPLY

During the past fiscal year, construction on the Hetch Hetchy project has been actively advanced. The work accomplished between July 1, 1916, the beginning of the past fiscal year, and December 31, 1916, was fully described in my progress report of January 29, 1917, to the Mayor, the Board of Public Works and the Board of Supervisors of the City and County of San Francisco. Excerpts from the said report are therefore included in the following description.

HETCH HETCHY RAILROAD

For conveying to the site of the Hetch Hetchy dam and upper tunnel aqueduct the 233,000 tons of construction equipment and material necessary for the work, a standard gage railroad was projected, previous to 1916.

Contract for the construction of this railroad was awarded on December 6, 1915, to F. Rolandi, for the estimated sum of \$1,543,080.74. Actual construction was begun in February, 1916, and at the present time the grading is practically complete and track laying has been advanced to within 20 miles of the damsite.

This railroad extends eastward into the Sierras from Hetch Hetchy Junction (formerly Rosasco), a station on the Sierra Railway of California, 10 miles south of Chinese. The elevation of Hetch Hetchy Junction is 935 feet, from

which the railroad after crossing two low ridges drops to 625 feet in a distance of 9 miles to cross the Tuolumne River some 12 feet above extreme high water. From this crossing, the road continues along the river canyon past Jacksonville, thence up Moccasin Creek and Grizzly Gulch to Priest's and thence to Big Oak Flat and Groveland. Most of the climb for eastward traffic toward the dam is on a grade of from 3 to 4%.

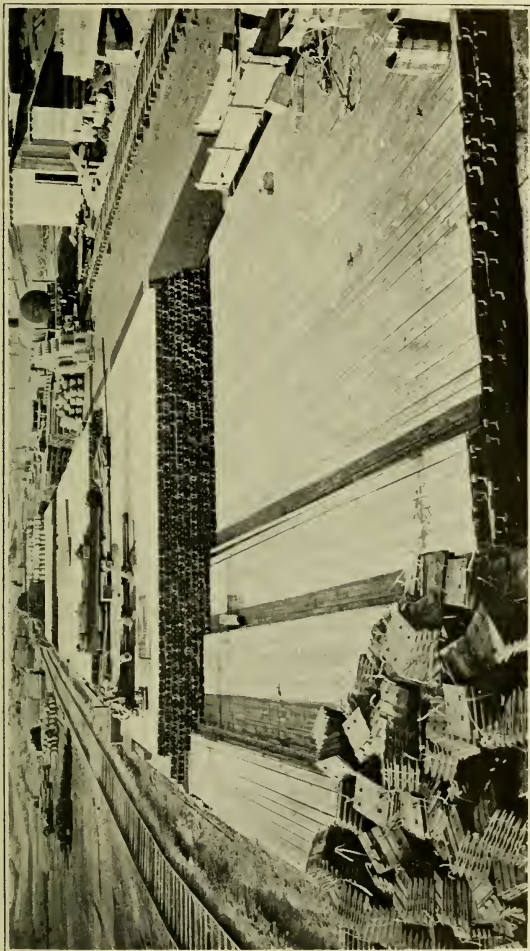
Due to the roughness of the country, and since the road is to be operated for freight traffic chiefly, heavy construction cuts have been avoided so that sharp curvature has been frequently used, the maximum being 30° , and curves of from 18 to 26° are numerous.

From Groveland the road continues east past Hamilton Station; thence it descends to the South and Middle Forks of the Tuolumne River, which are crossed on ballast deck trestles and finally ascends to Poopenaut Pass, where an elevation of 5024 feet is attained; thence on a continuous 4% grade descends to the damsite bench at 3869 feet elevation. This latter stretch of the road, 9 miles in length, was exceedingly rough construction, in many instances having been hewn out from almost vertical granite cliffs.

Over 1,000,000 cubic yards of excavation were necessary for the roadbed. About one-fourth of this was in rock and over one-half million feet of lumber was used for trestling the various small canyons which the road crosses.

For excavation, the material was classified as granite, solid rock, soft rock and earth. Alternate bids were invited for this classification and for payment on the basis of unclassified excavation. It was found more desirable to award the contract on the latter basis, 67 cents per cubic yard being paid the Contractor for excavating all classes of material.

For all but the 9 miles descending from the summit of the ridge at Hog Ranch into Hetch Hetchy Valley, the width of the roadbed is 16 feet at subgrade. For this 9 miles the width is 22 feet. Slopes on embankments are $1\frac{1}{2}$ horizontal to 1 vertical.



Material Yard, Hetch Hetchy Railroad.

Ties are of redwood and of Oregon pine 6 x 8 in x 8 ft. Rails are 60-pound sections, and ballast is 6 inches deep under the ties and must extend 6 inches beyond their ends.

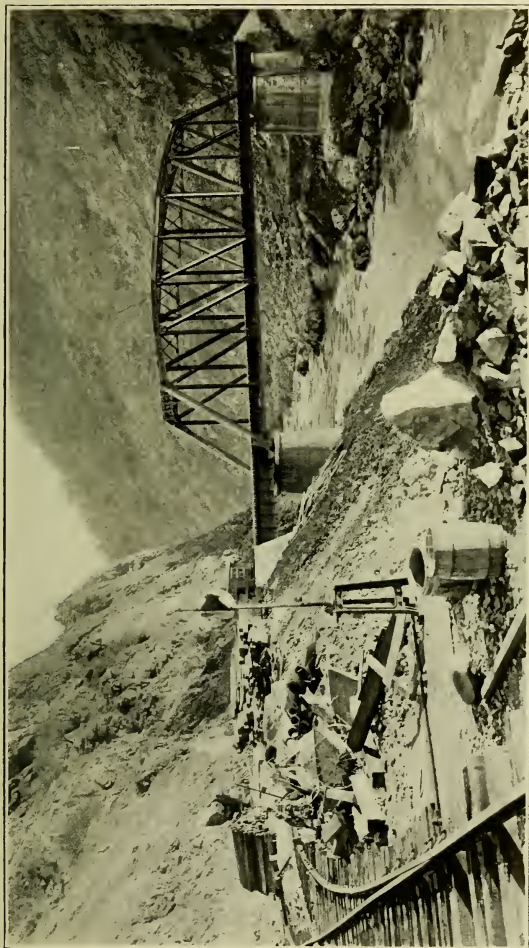
Across the Tuolumne River below Jacksonville, the road is carried on a steel railroad bridge with a clear span of 220 feet and deck plate girder approaches. The plate girders have a span of 40 feet and are supported by reinforced concrete piers, as is the main bridge structure.

The bridge was supplied to the Contractor by the United States Steel Products Company, and was designed according to Cooper's Standard Specifications E-35, to carry two locomotives each weighing 124,000 pounds followed by a uniform load of 3500 pounds per lineal foot of train.

The maximum compressive stress allowed on ties and floor timbers is 1,000 pounds per square inch. The bridge was designed for a wind pressure of 30 pounds per square foot on the exposed surface of all trusses and floor system, in addition to the pressure on a train surface having an average height of 10 feet beginning 2 ft. 6 in. above base of rail. A variation of 150° in temperature was provided for in computing temperature stresses.

This structure is located only a short distance from the Eagle Shawmut gold mine. The fumes from the chlorination works of this property have an exceedingly corrosive effect on steel structures, for which reason the painting of the railroad bridge was not included in the specifications, but will be done directly under the supervision of the City Engineer.

Besides providing for a location which would involve a minimum cost and would be continuous to all important points of the Hetch Hetchy Aqueduct, the line was located with a view of passing through that portion of the territory which might later furnish freight, in case it was decided to operate the road as a common freight carrier. The wisdom of this course has been strongly emphasized by numerous offers of freight, in case the City cares to handle the same. This subject will be discussed later in the present report.



Tuolumne River Bridge, Hetch Hetchy Railroad.

In April, 1916, the State Engineer attempted to compel the City to construct and maintain numerous separate overhead crossings at all points where the Hetch Hetchy railroad intersects the Tioga (or Big Oak Flat) Road, which was the main county road from Chinese to Yosemite National Park and had recently been acquired by the State from the County. After a vigorous protest by representatives from the City Engineer's and City Attorney's offices, before the State Railroad Commission, this matter was adjusted to the satisfaction of the City and the policy of the City Engineer sustained. Great care will be maintained in operation at all of the crossings and it has been agreed that at the dangerous one near Stevens Bar, all trains will come to a full stop before crossing the road.

Great difficulty has been encountered in securing a right of way over a mining claim on the grade up from Moccasin Creek toward Priest. The claim was demonstrated by the City's geologist to be of little value but it was necessary to undertake condemnation proceedings to secure title to the right of way across it. This action was tried in the Superior Court of Tuolumne County in January, 1917, and the right of way secured by Court judgment for \$160. The price asked by the owners of the claim was \$100,000.

In view of the fact that the Hetch Hetchy Railroad will soon be ready to transport materials from the Sierra Railway to the Hetch Hetchy dam and to intermediate points along the Hetch Hetchy aqueduct, it is essential that arrangements be made in the near future for the operation of the line.

The railroad passes through forests of great extent which have not as yet been touched by the lumber men because of their remoteness from any cheap means of transportation which would enable them to market their products.

The same trains which haul materials eastward to the City's works will be able to haul the products of these forests westward, with little inconvenience to the City's business, and any profits from this hauling should be applied to reduce the net cost of the Hetch Hetchy project an appre-



Detail of Tuolumne River Bridge.

ciable amount. It is therefore contemplated to operate the railroad so as to handle as much freight as possible.

The heaviest traffic will occur in 1918 and 1919, with over 75,000 tons in each of those years, requiring a daily haulage of 320 tons.

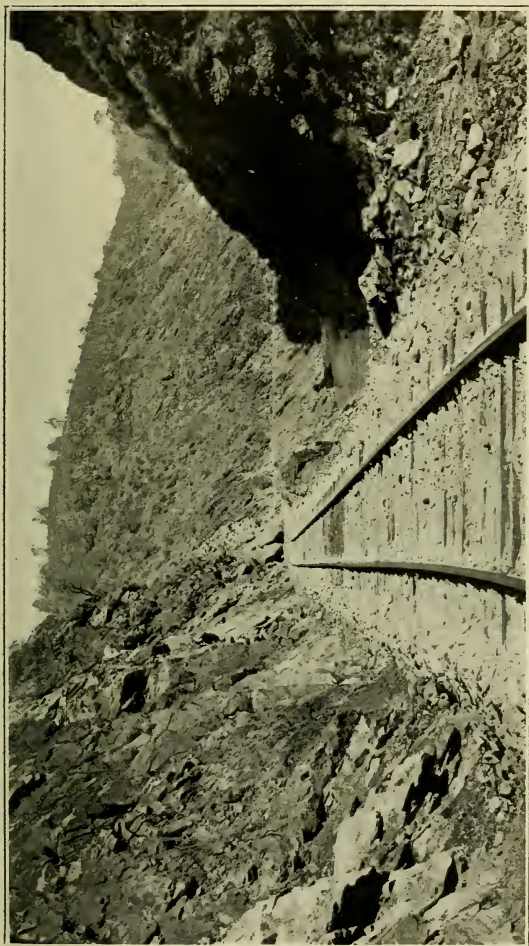
It has been proposed that instead of operating the railroad with a force employed directly by the City, the operation of the line be entrusted to one of the railway companies operating in territory adjacent to the City's road, under an agreement which would work out to the advantage of both parties.

The companies considered have efficient organizations fully equipped for handling railroad business, and by placing the Hetch Hetchy line under such management, subject to general supervision of the City's own officials, a co-ordination of labor and an avoidance of duplication in the operating staff and equipment could be effected, which might result in the saving of considerable money, especially during the periods of light traffic, when the overhead costs for separate operation would bear a much higher proportion to the total costs. The City would also be relieved from the necessity for making any outlay for equipment and the investment by the private company for new equipment would be relatively small, as much of the necessary rolling stock would be furnished from that which it has already on hand.

If the road is to be operated by a contracting company the conditions would be as follows:

The City Engineer of San Francisco would act as General Manager and the Second Assistant City Engineer as Assistant Manager. The City would employ the accounting force and the station agents, in order to keep account of the traffic passing over the road and to check up the cost of operation. The City would also pay the per diem charge for hire of equipment.

The existing administrative staff of the operating company would have the immediate supervision of the operation of the Hetch Hetchy Railroad. This would add very



Typical Section Hetch Hetchy Railroad.

little to the expense of administration already paid by said company.

All employees required in the various operating departments would be employed by the contracting company. This covers section gangs, bridge and building maintenance men, machinists and other shop men, train crews, enginehouse employees, train dispatchers, etc.

The operating company would furnish all necessary locomotive and other rolling stock, fuel oil, and other supplies, would maintain the equipment, and would be liable for loss and damage to freight and for accidents of any description.

A tentative suggestion as to the compensation to be paid for these services is that the City should pay the wages of all employees engaged in the maintenance of the Hetch Hetchy Railroad and in the hauling of trains over the City's rails; the wage of shop men engaged in making ordinary repairs to rolling stock used on the Hetch Hetchy line, and the cost of all necessary materials and fuel. In addition to the compensation for this direct cost, the City should pay some proportional figure possibly about 10% of the direct cost, which will cover general administrative expense, legal expense, insurance, accidents, claims for loss and damage, and profit.

The rates charged for transportation should not only cover the expense of operating the road but should also, in the final summation, pay the cost of constructing and equipping the road (less salvage value at the time its usefulness to the City ceases), as well as interest on that cost.

Depreciation of equipment is charged as an operating expense and should not be included in figures on amortization. For the purpose of estimating transportation rates it is assumed here that one-tenth of the cost of the road, less the items having salvage value, is amortized annually, being repaid to the City in the form of freight rates.

Interest at $4\frac{1}{2}\%$ per annum on the net amount invested in the road and equipment should also be covered by the rates. The term "net amount invested" is here used to des-

ignate the total original investment less the accrued amortization charges. It would obviously be inconsistent to charge interest on money already repaid.

The original investment is \$1,850,000, and the annual amortization charge is taken at \$165,000, which will be deducted at the end of each year to determine the "net amount invested." The interest charge for the first year will be $4\frac{1}{2}\%$ on \$1,850,000; for the second year, $4\frac{1}{2}\%$ on \$1,685,000, etc.

In order to make the railroad self-supporting, paying all costs of operation and maintenance, interest on cost of construction and equipment, and amortization of cost of construction, it has been estimated that it will be necessary to charge for transportation at the following rates:

Passengers.....	$7\frac{1}{2}$ cents per mile.
Freight.....	15 cents per ton-mile.

On this basis the tariff charged for transportation of a ton of freight from Hetch Hetchy Junction to Hetch Hetchy damsite would be \$10.15 and the passenger fare \$5.

In the figures here presented no account has been taken of the possible development of freight traffic other than the hauling of construction materials. To fix a rate for the hauling of lumber for private parties, due consideration must be given to all the elements bearing on the cost.

Practically all freight hauled over the Hetch Hetchy Railroad will be hauled in the same cars in which it is shipped from the points of manufacture or other points at which it is loaded on to cars. A charge per car-day will be made against the road for the use of the cars. The per diem charge under present rules is 75 cents, irrespective of the class or capacity of the freight car. The amount is charged under an agreement as to interchange of cars between carriers which went into effect September 1, 1916, and terminates May 1, 1917, at which time a new rate is to be fixed, not to exceed \$1.25 per day. Prior to September 1, 1916, the rate was 45 cents per day. There is no means

of predicting whether the present rate will remain in effect or a higher or lower rate take its place. The present estimate is based on the existing rate.

The Hetch Hetchy Railroad could be operated by the City under the immediate direction of the City Engineer, unless an arrangement more economical and satisfactory to the City is advanced by one of the railroads above named. In any event, its operation and policies must be absolutely controlled by the City.

LOWER CHERRY RIVER POWER DEVELOPMENT

As noted in my recommendation of March, 1916, it had been determined to erect at Early Intake a temporary power plant for construction purposes. This plant, referred to as the Lower Cherry River Power Development, will generate all of the electric power required for construction purposes for the entire project, from the main Hetch Hetchy dam to Moccasin Creek.

Water for this installation is diverted from Cherry Creek into a conduit of 200 second feet capacity, 3.3 miles long, consisting of 1.4 miles of open ditch, 3 flumes aggregating 0.9 mile, and 5 tunnels aggregating 1 mile. Five of the tunnels were drifted under contract by MacArthur Brothers, but the balance of the work is being done by the City's forces.

The pressure pipe line connecting the water wheels with the forebay at the lower end of the ditch is 530 feet in length, of 42 inch diameter pipe, ranging in thickness from $\frac{3}{16}$ to $\frac{3}{8}$ inch.

Water wheels are Francis turbines operating at 720 R.P.M. under a maximum head of 346.5 feet, including a draft head of 15 feet. These turbines are each direct connected to 2300 V., 3-phase, 60-cycle generators, with direct connected exciter. The voltage will be stepped up through a single bank of transformers to 22,000 V. for transmission to the various sub-stations to be located along the 19 miles of

equeduct to the west and at the main Hetch Hetchy dam site 11 miles to the east of the power plant.

To insure sufficient water for operating purposes during the dry season, a temporary dam is required to raise the water level 30 feet at Lake Eleanor. It will be a multiple arch structure having a maximum height of 60 feet, with a length of 1150 feet.

A careful examination of Eleanor Dam Site was made by the City Engineer in 1917, and it was finally decided, after other sites and alternatives were considered, in the interest of economy, to build the temporary dam in such a location and in such a manner that it can later be made a part of the permanent dam. The latter structure will have a height in the future of 150 feet or over.

The design of the temporary dam will involve several original features. In buttressed arch dams heretofore constructed, it has been the custom for the central axes of the arches to be on a plane straight across the course of the stream. In one instance, namely on the Umatilla project of the United States Reclamation Service, a multiple arch dam was constructed for which the surface connecting the central axes of the individual arches was in itself curved upstream as an arch. In the Eleanor temporary dam the central axes of the arches will be on a curve arched upstream across the present narrow channel of Eleanor Creek, the arc subtending an angle of 30 degrees. Tangent to this central arc and extending to the abutments on each side of the present channel, the axes of the arches will lie in planes whose horizontal traces form an angle of 30 degrees.

There will be 22 arches, each with a span of 40 feet, supported by buttresses heavily reinforced. About 7,000 cubic yards of high grade concrete will be required in the entire structure.

Some 400,000 board feet of lumber will be used for the forms. From the Canyon Ranch sawmill to Eleanor damsite is a distance of 17 miles by road. Figuring on a cost of 50 cents a ton mile for haulage and the weight of the timber

as 3 lbs. per board foot, transporting the necessary lumber from Canyon Ranch to Eleanor damsite would cost approximately \$5,000. The economy of placing a small sawmill with a capacity of about 4,000 feet per day near Eleanor damsite and sawing some of the timber now standing in the reservoir area to avoid excessive hauling was clearly demonstrated.

The work of constructing the temporary Eleanor dam will be carried on by day labor under the direction of the City Engineer.

Large deposits of sand and suitable gravel were found within 2000 feet of the damsite.

Work on this structure will be commenced in August, 1917, by day labor under the direction of the City, and it is expected that the storage dam can be completed before July, 1918, in ample time to impound sufficient water for generating power during the dry season of that year.

The type of conduit in which water will be carried from Cherry Creek to the forebay of the power house has been modified from the temporary type considered desirable in the construction program for 1916. The change was rendered advisable when it was decided to use this conduit continuously for domestic water supply as well as for power generation. This consideration as well as the study of the geological and physical conditions dictated the advisability of constructing immediately $1\frac{1}{2}$ miles additional in tunnel instead of flume and canal and to line with concrete those portions of the existing canal which would be pervious to water. This has involved a great deal more time and expense, but upon completion will add greatly to the permanency of the installation and defer future reconstruction to a later date.

The dam on Cherry River required to divert the water into the aqueduct has been completed and the head gates installed, ready for operation. The tunnels and canal sections are completely excavated. Portions of the tunnels and canal must be lined with concrete. A rock crushing plant is

now being erected to crush the granite spoil from the tunnels to suitable size for use in the concrete. Flume bents are being erected but the flume box will not be constructed until nearly time to run water through it. The excavation for the pressure pipe trench has been completed with the exception of the bell holes and anchorages, which work will not be done except just in advance of the pipe laying. On the power house, concrete foundations for walls have been poured as well as the foundations for the generators, turbines and other machinery and appurtenances. The work has been somewhat delayed by exceptionally heavy floods in the Tuolumne River watershed.

Due to the unprecedented demand for construction supplies through the country affecting the delivery of materials and equipment, it was necessary to enter into contracts for the delivery of all of the hydraulic and electrical machinery during the past year, in order to insure delivery when required. Therefore it was deemed advisable to enter into a great many more contracts during 1916 than would have been necessary under normal conditions, and moreover this machinery and equipment has been purchased at from 15 to 25 per cent under the present prices.

HETCH HETCHY DAM AND RESERVOIR

At its lower end, Hetch Hetchy Valley narrows to a gorge about 60 feet wide at ordinary low water level (elev. 3,500) and 900 feet wide at the elevation of the crest of the proposed main dam (elev. 3,812). All external geological evidence and previous engineering reports and studies indicated that the greatest depth to bedrock below the bed of the stream would be about 40 feet. However, before sinking the cofferdam 100 feet up stream from the main dam, for the diversion structure, the City Engineer had wash borings made to determine the exact position of the underlying rock. Several of these borings penetrated the gravel and clay in the riverbed to a depth of over 100 feet without reaching rock in place.

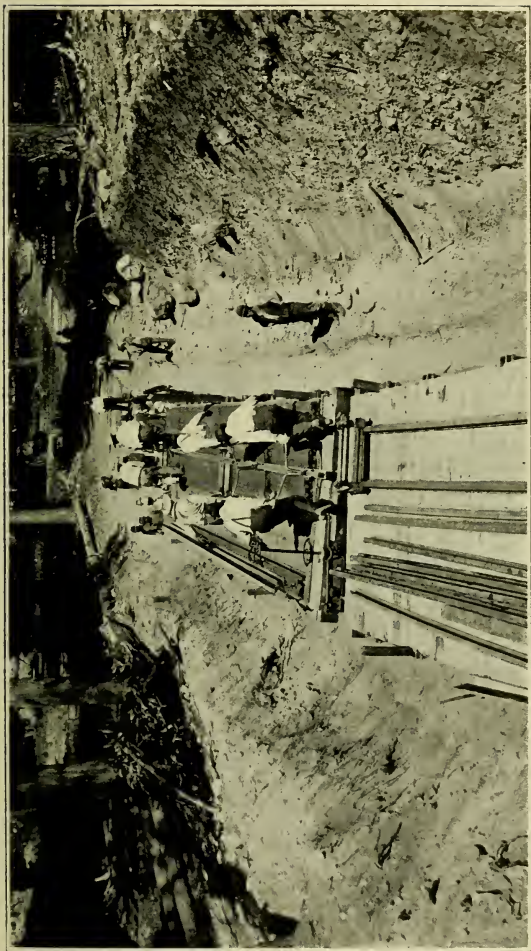
Immediately bids were called for making detailed core borings under main dam. Contract for this work was awarded to the International Diamond Drill Contracting Company. The amount of work to be performed under the contract was 1900 lineal feet of boring. In all, 20 holes were sunk, from which it was determined that the average depth from the river bottom to solid bedrock was 72 feet. This varies considerably along the axis of the dam, the greatest depth being 92.25 feet to bedrock, which at this point has an elevation of 3,393.75 feet above sea level.

The result of the diamond drill borings indicated that it would be necessary to build the diversion dam without excavating to bedrock. This diversion dam will be for temporarily diverting the Tuolumne River out of its course around the main damsite, while the construction of the main Hetch Hetchy dam is in progress.

During the past fiscal year a cofferdam was erected and the foundations for the diversion dam were poured. This constitutes the most difficult part of the work. All that remains will be the pouring of the concrete in the cofferdam and superstructure. In the interest of economy, it has been decided to include this in the contract for the construction of the main Hetch Hetchy dam. Much of the equipment used for constructing the diversion dam foundations will be used also for the construction of the Lake Eleanor multiple arch storage dam.

The diversion tunnel, partially completed during 1915, was finished during 1916. The diameter of the bore is 20 feet and its length 457 feet. The work was started with hand drills, but air drills driven from a compressor were used for the greater portion. The rock traversed is a very hard granite, and a large portion was saved for use in the concrete of the diversion dam. The cost at which this tunnel was finished proved very satisfactory, being approximately \$5 per cubic yard of rock excavated.

The easterly boundary of the Hetch Hetchy watershed extends along the summit of the Sierras for a distance of



Unloading Rail for Hetch Hetchy Railroad.

over 40 miles. Most of this region is of granite formation, devoid of soil or vegetation. In this area are the head waters of the Tuolumne, which flows in a northwesterly direction to the Hetch Hetchy Valley, which on completion of the main dam will be San Francisco's principal storage reservoir, with a capacity of 112 billion gallons.

Unlike the surrounding mountains, portions of Hetch Hetchy Valley itself were densely forested. The entire reservoir area must be absolutely cleared of vegetation before water for domestic purposes can be impounded. That portion of the valley that will be flooded when the diversion dam is completed has already been cleared.

Specifications for this work provided that all standing trees, brush and shrubs on the specified area would be cut down and either used for saw logs or cordwood, or burned. Oak, cottonwood, alder, maple and willow were cut and piled as cordwood, at a price of \$2.95 per cord. All softwood, including cedar, yellow pine, sugar pine and red fir, which were over 6 inches in diameter at the butt and which were considered suitable for saw logs by the City Engineer, were cut into 16 foot lengths or longer, peeled, left on cedar skids in piles of 5, 10, 15 or 20, at a cost of \$2.20 per M ft. B.M., and when the reservoir is flooded will be floated to the damsite and sawed into logs. Softwood less than 6 inches in diameter at the butt, or for any cause not suitable for saw logs, was cut into cordwood in the same manner as the hardwoods, at a price of \$2.45 per cord. All brush and timber not suitable for cordwood or logs was piled and burned. In this manner, 808 acres have been cleared at a cost of approximately \$50,000.

HETCH HETCHY AQUEDUCT

Present unsettled conditions, due to the world war, are not conducive to the most rapid and economic development of large enterprises. Prices for material and labor are continually advancing at an alarming rate so that the cost of any construction performed under present conditions will be far in excess of original estimates. Moreover, the great difficulty in disposing of bonds, readily marketable under normal conditions, must necessarily mean the curtailment of extensive operations in the immediate future.

On the other hand, it is highly desirable to complete as soon as possible the Hetch Hetchy dam and the tunnel aqueduct to Moccasin Creek power house forebay, in order to secure the income or saving that will result from the generation of electricity to the extent of 66,000 horsepower as an initial installation.

For this reason, it has been deemed expedient to advertise for bids to be received on August 22, 1917, for the construction of the Mountain Division of the Hetch Hetchy Aqueduct. If no reasonable and satisfactory bids are received but it is possible to dispose of the water construction bonds at par plus accrued interest, the tunnel can be constructed by day labor.

From Hetch Hetchy reservoir to Early Intake, a distance of 12 miles, the riverbed of the Tuolumne will temporarily serve as a conduit for the released waters, until such time as the necessity for the generation of additional power will justify the construction of a tunnel from Hetch Hetchy damsite to a forebay above Early Intake.

The aqueduct tunnel for the construction of which bids will be received on August 22 extends from Early Intake, on the Tuolumne River above the confluence of the Cherry River, to the site of the proposed regulating reservoir south of Priest's, all in Tuolumne County.

The work lies in rough mountain country. Wagon roads cross the line at several points. Freight for construction

purposes will be transported on the Hetch Hetchy Railroad, from Hetch Hetchy Junction to the sidings nearest to the work, at a cost to the contractor of 15 cents per ton mile over the portion of railway owned by the City. The Hetch Hetchy Railroad parallels approximately the line of the aqueduct so that the work will be accessible from the railroad by short road or tramway hauls.

The aggregate lengths of the tunnels to be constructed under this contract is about 18.3 miles, and has been divided into three sections, as follows:

Section "A" includes the tunnel about 4.5 miles in length, from Early Intake to the South Fork of the Tuolumne River. This tunnel can only be worked from the two portals, unless the contractor constructs an intermediate shaft at his own expense.

Section "B" extends from the South Fork of the Tuolumne River about 4.7 miles to an adit in the northeast quarter of Section 29, T. 1 S., R. 17 E. The work will be constructed from the portal at the South Fork and from 7 adits now being driven by the City. The adits divide the section into 7 parts varying in length from about 0.34 mile to about 1.07 miles.

Section "C" extends from the westerly end of Section "B" about 9.1 miles to a point in the City's forebay reservoir site about one mile south of Priest, practically cross-cutting the Mother Lode belt 2 miles wide. The work will be accessible from the west portal, from the adit at the easterly end of the section, and from two shafts to be sunk under the contract. The maximum distance between two consecutive points of access will be about 3.9 miles.

Any bidder may bid on all three sections, on two sections or only one section, and the City may award the contract as a whole to a single bidder or may award it in sections to two bidders, or if prices are excessive reject all bids.

The tunnels to be constructed will be lined with concrete and will be in the clear 10 feet 3 inches high and 10 feet 3 inches wide, inside of lining, with horseshoe shape

of cross-section. In Section "C" it may become necessary, should the ground become heavy, to change to a circular cross-section 10 feet 6 inches in diameter.

Before deciding to line the tunnels with concrete, an analysis was made under the direction of the City Engineer by L. W. Stocker, Assistant Engineer, to determine whether it would be more economical to dispense with the lining through hard rock formations that will stand permanently without support, and make the tunnel large enough so that the increased area of cross-section would compensate for the greater frictional resistance of the rough rock walls.

To compare the areas required for different shapes of cross-section, curves showing the relation of roughness of waterway and area of cross-section have been worked out for three shapes: (1) circular section; (2) horseshoe section; (3) arched section with vertical sides. The circular section requires less volume of excavation but is inconvenient for practical reasons. The horseshoe section requires a slightly larger excavation. The arched section requires still more excavation but is easier to construct than either of the other two. If the entire tunnel section is to be taken out at once, the arched section will be cheapest in spite of the slightly greater area of cross-section. It is more likely, however, that the heading and bench method of excavation will be used, in which case the horseshoe section should cost no more per cubic yard than the arched section. The horseshoe section has been used as the basis of the comparative cost estimate presented later.

The thickness of the concrete lining is taken nearly the same as that shown on page 120 of Freeman's Hetch Hetchy Water Supply report: average thickness desired in sides and top, 6 inches; average thickness desired in invert, 6 inches. There will, of course, be overbreak beyond the desired thickness of concrete, the amount of the overbreak varying in different formations of rock. It is assumed that the overbreak will be such as to add an average of 6 inches thickness of concrete to the desired thickness, making the average total thickness of concrete about 12 inches.

The diversion tunnel at Hetch Hetchy Damsite has a circular cross-section 20 feet in diameter. The upper 12 feet was taken out to full width first. The cost was about as follows:

	Area of section sq. feet	Cubic yards per lineal foot	Cost per lineal foot	Cost per cubic yard
Heading	197	7.3	\$42	\$5.75
Bench	117	4.3	18	4.20
Entire tunnel	314	11.6	\$60	\$5.25

This includes all items of cost except rails, cars, drill steel, recoverable tools, and overhead expenses. The tunnel is only about 500 feet in length, so no forced ventilation was necessary, and for the same reason the cost of hauling out the muck was very small. The cross-section area of the heading was greater than the entire cross-section of the aqueduct tunnel. The material penetrated was about the same as may be expected in the first eight miles of the aqueduct. It should therefore be safe to assume that the cost of excavating the aqueduct tunnel, not including hauling out the muck or ventilating, will not be less than \$5.75 per cubic yard.

In tunnel No. 1 of the Lower Cherry Aqueduct, 80 feet at the west end was drifted by the City on a day labor basis. The net section of this tunnel, much smaller than the aqueduct tunnel, is 1.98 cubic yards per lineal foot, and the cost of labor (hand drilling), powder, etc., was \$14.75 per foot or \$7.50 per cubic yard of neat section. The ground was very blocky and hence was a very heavy percentage of overbreak, but the excessive cost due to overbreak was compensated by the fact that all the workmen except blacksmiths received only \$3.00 per day, which is somewhat less than the usual rate for drillers. It would seem then that in the main aqueduct tunnel the cost of excavation, not including hauling and ventilation, should not exceed \$7.50 per cubic yard of neat section.

Considering these examples of cost, it seems that the excavation in the Hetch Hetchy aqueduct tunnels under con-



Laying Track, Hetch Hetchy Railroad.

sideration should cost about \$8 per cubic yard for labor, materials and power this figure to apply to the lined section, which contains 3.92 cubic yards per lineal foot to the neat line. The unlined and partly lined sections are considerably larger and the cost per cubic yard in such sections would be less. It is assumed in this estimate that the excavation in excess of that for the lined section will cost \$7 per cubic yard.

The cost per cubic yard of concrete, using a 1:2 $\frac{1}{4}$:5 mix, will be approximately:

	Cost per cu. yd. of concrete
Cement, 1.28 barrels @ \$3.75.....	\$4.80
Sand, .43 cu. yds. @ \$1.50.....	.65
Crushed rock, .95 cubic yd. @ \$1.25.....	1.19
Mixing, transporting and placing.....	2.00
Water supply, waste of materials, miscellaneous, say.....	.36
	<hr/> \$9.00

Moreover, the full lined section possesses advantages which, if the cost were the same for either type, would determine the choice in its favor. It precludes the possibility of rock falls after the completion of the tunnel, which might occur in an unlined section, even though the rock appeared perfectly sound, if for example excessive charges of powder were used in blasting and some loose pieces were not barred down from the roof or sides. The velocity of the water flowing in the lined section will be about double that in the unlined section, so that if any silt is carried past the settling chamber at the head of the aqueduct it will be carried on through and not deposited in the tunnel. If any cleaning should be necessary it will be much more easily and quickly done in a concrete lined section than in an unlined section with rough rock walls. These features, especially the first, are of sufficient importance even to warrant paying somewhat higher for a concrete lined tunnel than for an unlined tunnel having equivalent hydraulic properties.

Since the full lined section will prove more reliable in operation and cheaper to maintain, it has been adopted.

FUTURE STAGES OF AQUEDUCT CONSTRUCTION

Another tunnel 5.75 miles in length will extend from Moccasin Creek to Red Mountain Bar, where the Main Tuolumne River will be crossed with a short steel pipe. Thence a tunnel 11.4 miles in length will lead to Oakdale Portal, on the easterly side of the San Joaquin Valley.

From Oakdale Portal (about 4 miles southeasterly from the town of Knights Ferry), the commencement of the present survey, to Tesla Portal on the west side of the San Joaquin River, (about 8 miles southeasterly from Tracy), the aqueduct will consist of 45.2 miles of steel pressure pipes. The thickness of the steel pipe, and hence the cost, is practically proportional to the water pressure, therefore the pipe line was located on the highest ground immediately adjacent to the direct or shortest line to be followed.

Across the thickly populated Oakdale and Modesto irrigation districts, the location has been such as to offer the least damage to the valuable lands and crops, in case of a break in the pipe line.

The San Joaquin River crossing has been selected so as to permit of structures offering the greatest safety during the annual overflow of the San Joaquin River. This intersection fortunately lies practically on the most direct line of the aqueduct, and although not considered in previous studies, is found to be the shortest crossing. The aqueduct will be carried under the river in a submerged pipe line and the lower areas adjacent to the San Joaquin, subject to overflow during the annual floods, will probably be traversed by means of pipe lines on substantial reinforced concrete trestles.

Through the Coast Range from Tesla Portal to Irvington Gate House, except for a small steel siphon crossing the Alameda Creek channel, the aqueduct will consist of tunnels aggregating approximately 31 miles in length. This section has been the subject of close geological study and the surveyed location made follows what is at present considered

the most feasible route avoiding fault lines and rock of uncertain character. The location for the route 6 or 7 miles immediately west of Tesla Portal is as yet uncertain. For this portion, several alternative lines were surveyed and final selection must be based on more definite knowledge to be obtained by test holes which will be sunk along the several routes.

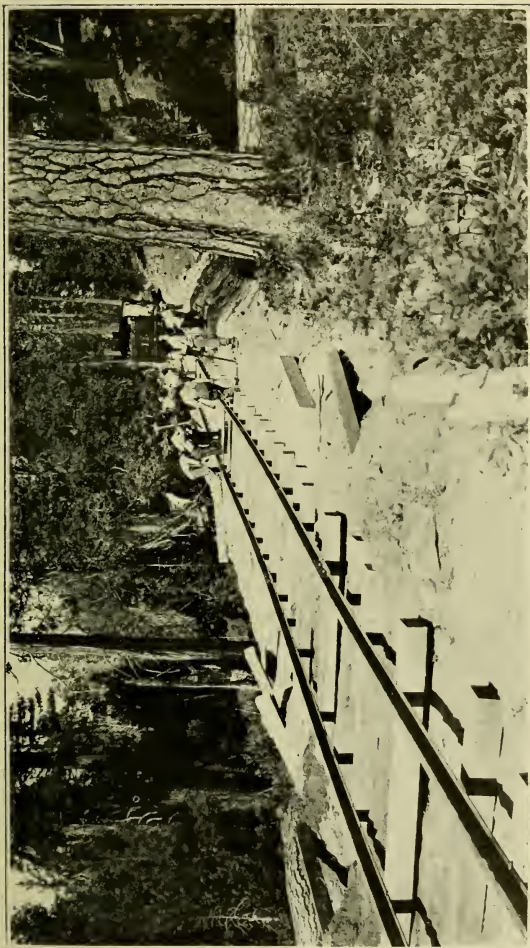
From Irvington Gate House westerly, the aqueduct will again consist of steel pressure pipe 19.1 miles in length, following practically a straight line from the Gate House to Dumbarton Straits, where the Bay crossing will be made by means of submarine pipes.

The line thence parallels the Southern Pacific Railroad, through the southerly portion of Redwood City to what is known as the Redwood City Portal, 2 miles westerly from the town of Redwood. Here the aqueduct will consist of tunnels, extending about $1\frac{1}{2}$ miles westward from the Redwood City Portal to the main ridge between San Francisco Bay and Crystal Springs and San Andreas Lakes of the Spring Valley Water Company.

From this point, the tunnels will follow beneath this main ridge to a point about one mile southwesterly from Baden Station. Here the waters will again enter a short steel siphon, across the low area lying between the main Coast Range and San Bruno Mountain to the San Bruno Portal, crossing the southeast corner of Holy Cross Cemetery and about 500 feet east of the Foothill Boulevard. From the San Bruno Portal to University Mound Reservoir will be in tunnel.

The location of the route has been made in the light of careful engineering studies, the controlling consideration being the permanence of the necessary structures, and the safety of the same, commensurate with reasonably economy.

With our source of water supply over 150 miles from the City, great care must be exercised to guard the aqueduct against possible interruption of service, due to any contingency whatsoever. Tunnels intelligently located and prop-



Spiking Track—Hetch Hetchy Railroad.

erly built will last for all time. Moreover, the expense of construction, in comparison with high pressure pipe of large diameter, is not excessive, when the cost of wide right of way for the latter is considered. Based on a comprehensive geological study of all practical routes, tunnels have been located in stable rock formation, as far as possible, free from the menace of earthquake faults.

The surveys, and levels accompanying the same, have been very accurately made, great care being exercised throughout to insure the reliability and accuracy of the final results. All portions of the line have been checked by means triangulation, levels have been checked with U. S. Geological Survey bench marks, and all property lines traversed by the route have been measured and the records of ownership, etc., have been compared with County records; so that when the mapping is completed, necessary data will be at hand for the acquisition of the right of way.

WATER RIGHTS AND PROTECTIVE WORK

Since the City secured the Hetch Hetchy grant, construction has been carried on continuously, to the end that there should be no cessation of work that would imperil the City's water rights.

The Early Intake wagon road has been extended by the construction of an 80-foot span bridge across the Tuolumne River connecting with a road to the Lower Cherry power house and up Cherry River to near the diversion damsite.

A new road has been started from the Hetch Hetchy Valley to Lake Eleanor. This will be about 10 miles long, and in December, 1916, when snows forced the temporary cessation of the work, 5 miles has been constructed. It will be completed during the summer of 1917. It is built on a 12% grade with a 10-foot roadbed. From a point near Hetch Hetchy damsite, it climbs 1800 feet over the steep cliffs on the northerly side of the valley by a series of "switch-backs" to over 5,300 feet elevation, then descends via McGill Meadows to Lake Eleanor. The primary use for which this road is intended is the transportation of material

to the Lake Eleanor dam, which is to be built as a part of the Lower Cherry power development. It will also serve during the construction of the main dam at Lake Eleanor in the future.

Work has begun on a road along the south side of Hetch Hetchy Valley, as required in the Hetch Hetchy grant. Continuous repair work by the City has been necessary on the roads from Chinese to Hetch Hetchy Valley, as neither the State nor Tuolumne County has funds available to have maintained them in reasonably good condition for heavy traffic.

A road has been constructed from the railroad grade near Middle Fork down across the Red Hill road and into the South Fork gorge. This road crosses the Middle Fork just below the falls near its confluence with the South Fork and leads to the southwesterly portal of tunnel No. 1 of the main aqueduct.

DEFENSE AGAINST OPPOSITION WATER AND POWER COMPANIES

Under date of April 28, 1917, the Secretary of the Interior upheld the contention of the City that the Yosemite Power Company by its water appropriation and application for permit in the Poopenant Valley secured no vested right or other right to occupy public or park lands and that granting the Company's application and construction of its plants would interfere with the City's plan for water development; and that Congress intended to extend to the City free opportunity to develop the water resources of this portion of the Tuolumne River without interference or diminution by application of permits by other parties.

The denial of these applications has been a great victory for the City as the construction of aqueducts and power houses by a competing power company would materially conflict with the City's proper operation of its Hetch Hetchy system. Due credit should be given to the consistent support from the City Attorney's office, and the earnest energy of special attorney Searls in making the legal presentations on those controversies.

STREAM MEASUREMENTS

Hydrographic and meteorologic observations have been continued at Hetch Hetchy, Lake Eleanor and Cherry Creek.

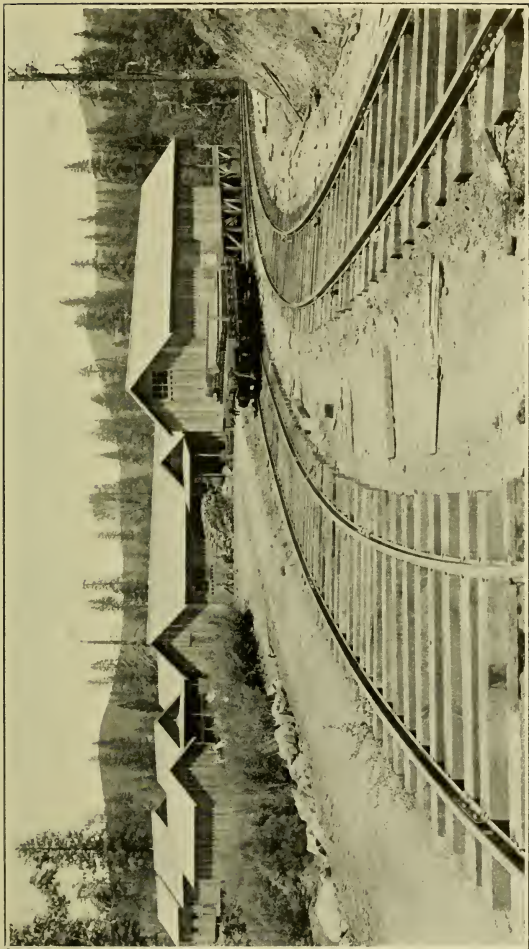
The United States hydrographer who has heretofore lived in Hetch Hetchy Valley has been removed to the junction of South Fork and Main Tuolumne Rivers, where a new cabin has been erected. The gage at Hetch Hetchy Valley will hereafter be read by one of the assistant engineers engaged on the City's construction.

New gaging stations have been built on South Fork and on Middle Fork of Tuolumne River. In construction of the aqueduct for Lower Cherry power house, the diversion dam has been so made that it can be used as a weir; by this means enabling us to secure reliable runoff records of Cherry River, which is the combined flow of Cherry and Eleanor Creeks.

CANYON RANCH SAWMILL

Logging and yarding for the year 1916 was begun on April 23, but the mill was not run until late in June. The season's run for 1916 amounted to over 1,600,000 board feet of rough lumber, besides a considerable quantity of surfaced material. In the spring of 1917 a planer was purchased in Sonora and added to the present equipment of the sawmill, necessitating the construction of a small building. Lumber is now being surfaced regularly, most of it being for use on the flume of the Lower Cherry power development. A second logging engine was purchased in the fall of 1916. Over 400,000 board feet of lumber were cut and planed during the spring of 1917.

Three hundred and twenty acres of additional timber land, known as the Dudley property, lying a short distance from the Canyon Ranch Sawmill, were purchased by the City, and it was proposed to cut about 4,000,000 feet more from this land. An agreement was made with the Department of Interior, however, whereby any or all of this 4,000,000 feet could be cut from selected trees standing on Government land immediately adjacent to the mill. This will prove a



South Fork Siding, Hetch Hetchy Railroad.

great convenience to the City, and will also preserve the beauty of the surrounding forest, by permitting of scattered trees being taken from a wider area and consequently no one particular spot will be entirely denuded. The Government will obtain the fee title to this land and the remaining uncut timber when the City's operations are completed, in full compensation for all timber cut or to be cut in future in the Hetch Hetchy reservoir basin and on Government land surrounding Hetch Hetchy Valley.

GROVELAND OFFICE BUILDING

At Groveland, an office building has been erected to serve as main headquarters for all work in Tuolumne County. This is a two story, frame structure, with rooms for offices, drafting, blueprinting, small store rooms and some living quarters. A steam heating plant has been installed as the winter weather in Groveland is very severe. The cost of the building and equipment amounted to \$5,740, and the cost of the adjacent warehouse was \$800.

CAMPS

A new camp has been established between South Fork and Middle Fork on the railroad. This camp is for permanent use during the construction of the main aqueduct, which at this point will require about four years for completion. A special use permit for this site was issued by the District Ranger of the Stanislaus National Forest. This camp has been improved by the construction of fairly good buildings, barn, etc.

Several temporary camps were used during the construction of aqueduct adits from South Fork westerly toward Big Creek. At present the only one of these which is still occupied is Greek Camp near Hamilton Station, which will continue to be a distribution point for supplies.

Temporary camps have been established at Lake Eleanor and at McGill Meadows, and will be maintained during the period of construction of the Hetch Hetchy-Lake Eleanor wagon road.

MISCELLANEOUS SURVEYS

During the time when most grading was being done on the Hetch Hetchy Railroad it was necessary to maintain six survey parties for the direction of grading work. These parties have set all construction points for the railroad work, have located all structures, cuts and fills, and have made all estimates of work done. Supervision and inspection of railroad construction has been under these same parties, but since the bulk of the grading work has been completed the number of parties has been reduced to three.

A plane table survey was made of the country between the railroad and the aqueduct from South Fork westerly to Red Mountain Bar. Some of this work presented considerable difficulty late in the fall when the snow and ice made work on the steep slope of the Tuolumne River gorge perilous.

In connection with rights of way for both railroad and aqueduct a number of land surveys have been made by the regular surveying parties engaged on work in the vicinity.

APPLICATIONS TO DEPARTMENT OF INTERIOR

Under the conditions of the Hetch Hetchy Grant, it was necessary that the City file application maps for all rights of way, etc., to be used in connection with the Hetch Hetchy project within 3 years of the signing of the Grant, by the President on December 19, 1913.

During the year there were filed with and approved by the Department of the Interior the following maps:

Amended Hetch Hetchy Tunnel Aqueduct from Early Intake to vicinity of Hamilton Station, filed July 3, approved September 12;

Road from Hetch Hetchy Valley to Lake Eleanor, filed October 14, approved December 30.

The following 12 maps were filed December 13, and approval thereof is still pending:

Hetch Hetchy aqueduct and transmission line from Priest Reservoir to Red Mountain Bar;

Amended location, Lower Cherry aqueduct and Lower Cherry power plant;

Road from Hamilton Station to Lake Eleanor—portion within Yosemite National Park;

Road from Hamilton Station to Lake Eleanor—portion within Stanislaus National Forest;

Railroad yard, gravel pits, spur tracks and tramways near Smith Station;

Camp and quarry sites and railroad loop at Hetch Hetchy dam site;

Road from Jones Station to Early Intake and junction of Cherry and Tuolumne Rivers;

Amended Hetch Hetchy aqueduct from Hamilton Station to Priest Reservoir;

Early Intake diversion dam site, aqueduct line, power plant site, pressure pipe and tunnel line, and electric transmission line;

Electric transmission lines from Early Intake to Hetch Hetchy, Lake Eleanor and Cherry Valley and from Early Intake to Moccasin Creek;

Hetch Hetchy tunnel aqueduct through Section 4, T. 4 S., R. 4 E., a portion of the Coast Range tunnel, near Carnegie.

HETCH HETCHY CONTRACTS OPERATIVE DURING 1917

Contract No. 6: "For Furnishing Hoisting Engine and Boiler," was awarded on October 11, 1915, to A. L. Young Machinery Company. The engine originally furnished under the contract proved defective and was replaced by the Contractor. Final payment was recommended February 20, 1917. The total amount of the contract was \$1357.

Contract No. 7: "For the Construction of the Hetch Hetchy Railroad," was awarded on December 6, 1915, to F. Rolandi for the estimated sum of \$1,543,080.74. At that time there was not sufficient money available for the award to be made, due to failure in selling $4\frac{1}{2}\%$ bonds, but on February 15, 1916, funds being available, the Auditor certified the contract. Actual construction was begun on February 11, 1916. The total estimated value of the work completed June 30, 1917, was \$1,437,411.33.

Contract No. 10: "For Drifting Tunnels, Lower Cherry Aqueduct." Proposals were received August 9, 1916,



South Fork Portal, Main Aqueduct Tunnel.

and the contract was awarded August 11th to MacArthur Brothers Company for the estimated sum of \$53,785.

This work proceeded slowly, due to conditions unforeseen by the Contractor and also to slow delivery of machinery.

This contract was for drifting five of the tunnels on the Lower Cherry aqueduct. The total length for the drifting of which proposals were received was 4400 feet, but the City did a portion of this before the Contractor was able to begin work, leaving a total amount to be drifted by the Contractor of 3950 feet. Final payment was recommended April 18, 1917, the total amount of the contract being \$40,465.96.

As these tunnels are to be permanent, it will be necessary to line porous portions of them with concrete where there is blocky caving rock.

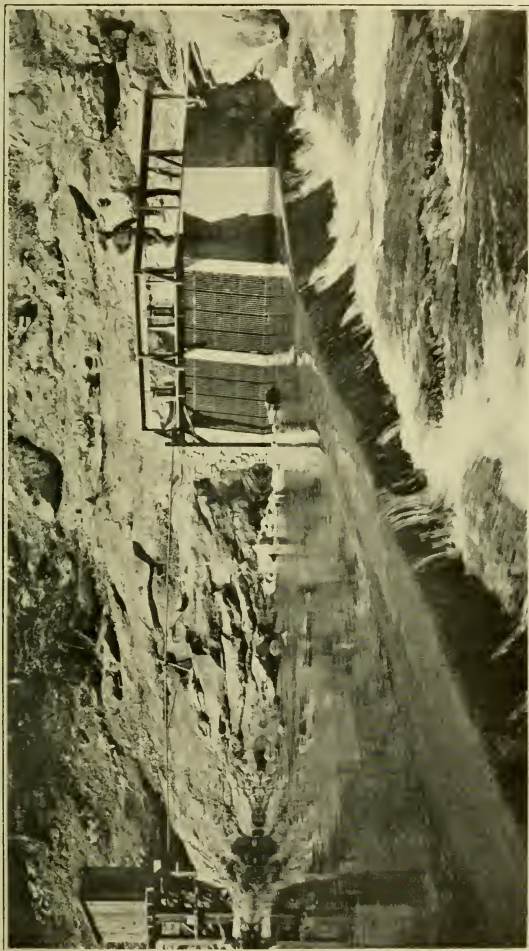
Contract No. 11: "For Making Core Borings, Hetch Hetchy Aqueduct." Proposals were received July 26, 1916, and contract was awarded July 28, 1916, to International Diamond Drill Contracting Company, for the estimated sum of \$24,923.29.

The work was prosecuted in a very satisfactory manner and final payment was recommended January 11, 1917. The total amount of the contract was \$20,002.13.

The core recovery on drill holes was very high and the samples representing the material which will be encountered in tunnel construction are stored in the Groveland office.

The work as bid on was for drilling 10 holes along the Hetch Hetchy aqueduct from Early Intake to Priest Regulating Reservoir. The total length of holes included in the contract was 7584 feet. Owing to the relocation of a portion of the aqueduct line between South Fork of Tuolumne River and Priest Reservoir, this quantity was cut to 5949 feet. The borings show very good material through which the tunnel aqueduct will be drifted.

Contract No. 12: "For Furnishing and Delivering Hydraulic Machinery and Equipment, Lower Cherry River



Diversion Dam and Intake, Lower Cherry Creek Power Aqueduct.

Power Development.” Proposals were received August 9, 1916, and the contract awarded August 16, 1916, to the Pelton Water Wheel Company in the sum of \$18,814, and a possible bonus of \$1000.

The machinery to be furnished under this contract was completed on December 1, 1916, and was shipped to Chinese, from which point it was hauled to Early Intake.

The machinery covered by this contract includes three 1500 h.p. Francis turbines, complete with governors, relief valves, and gate valves, together with all accessories. Payment has been made on the whole excepting the bonus, which payment will be made after testing the machinery.

Contract No. 13: “For Furnishing and Delivering Electric Generators and Exciters, Lower Cherry River Power Development.” Bids were received August 9, 1916, and the contract awarded August 16, 1916, to the General Electric Company in the sum of \$14,321.

The machinery was delivered to Hetch Hetchy Junction, to be hauled over the Railroad to Jones Station and thence by team to the Power House. Final payment has not yet been recommended.

The machinery to be furnished under this contract consists of three 1000 KVA generators, with direct connected exciters, and one motor generator exciter.

Contract No. 14: “For Furnishing and Delivering Electric Switchboards and Equipment, Lower Cherry River Power Development.” Bids were received September 13, 1916, and the contract awarded September 20, 1916, to the General Electric Company in the sum of \$2,849.50.

This contract covers the furnishing of the complete switchboard, with all necessary instruments and switches for the three generators and exciters to be furnished under Contract No. 13. The equipment has all been delivered but final payment has not yet been made.

Contract No. 15: “For Furnishing and Delivering Electric Transformers, Lower Cherry River Power Develop-

ment." Bids were received September 6, 1916, and the contract awarded September 8, 1916, to the Westinghouse Electric Manufacturing Company in the sum of \$7700. Delivery of the transformers was made in March, 1917, but final payment has not yet been made.

This contract covered the furnishing and delivering of four 1000 KVA oil insulated, water cooled, outdoor type, electric transformers and an oil filter.

Contract No. 16: "For Furnishing and Delivering Cedar Line Poles, Lower Cherry River Power Development." Bids were received September 20, 1916, and all bids were rejected as it was possible to secure poles usable locally at one-third the cost of the prices bid.

Contract No. 17: "For Furnishing and Installing Riveted Steel Pressure Pipe Line, Lower Cherry River Power Development." Bids were received October 20, 1916, and the contract awarded October 27, 1916, to the Western Pipe & Steel Company in the sum of \$7558.

This pipe has all been shipped to Early Intake and will be installed as soon as the excavation at the power house site and intake has been completed.

Under date of February 2, 1917, a first progress payment was recommended in the amount of \$2250.

Contract No. 18: "For Furnishing and Delivering Bare Copper Wire, Lower Cherry River Power Development." Bids were received October 18, 1916, and the contract awarded to John A. Roebling's Sons Company, on November 10, 1916, in the estimated sum of \$20,172.70.

After the contract was awarded advantage was taken of a provision in the contract, and the quantity increased by 25%, raising the contract price to a total of \$25,215.58.

Delivery of this material was made in April, 1917, and final payment was recommended May 25, 1917.

The quantity of wire to be furnished under this contract is sufficient for the construction of 38 miles of 3-phase transmission lines and branches.

Contract No. 19: "For Furnishing Logging Road Engine." Bids were received October 18, 1916, and contract awarded October 20, 1916, to Leland Equipment Company, for the sum of \$2490.

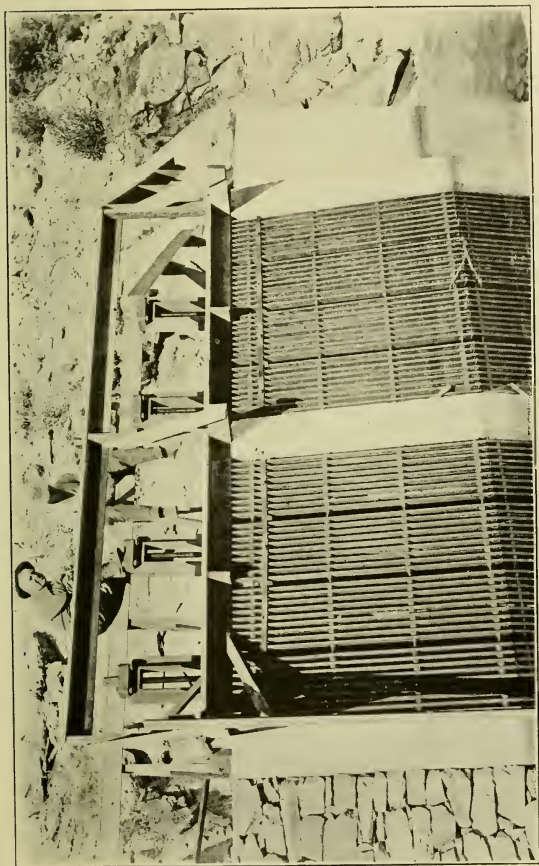
The engine purchased under this contract is a duplicate of the one purchased in 1915 under Contract No. 3, which has proved very satisfactory.

It is to be used for logging from the lands adjacent to Canyon Ranch Sawmill and when this work is completed, will be used in the construction of the Hetch Hetchy Dam.

Contract No. 20: "For Furnishing and Delivering Insulators, Crossarms and Pins, Lower Cherry River Power Development." Bids were received December 1, 1916, but as there were no bids covering all of the material, proposals were again invited and received December 11, 1916, and the contract awarded to Person, Roeding Company, on December 13, 1916, in the sum of \$2956.48. Delivery was made on all of the material in April, 1917. Final payment has not been made.

Contract No 21: "For Making Core Borings at Hetch Hetchy Dam Site." Bids were advertised to be received by the Board of Public Works on December 27, 1916, but none were submitted. This work was readvertised, proposals received January 5, 1917, and the contract awarded to the International Diamond Drill Contracting Company at an estimated price of \$14,675. This contract will include about 1900 feet of borings at the Hetch Hetchy damsite and will determine the character of the formation, both below the riverbed and up on the slopes.

Contract No. 22: "For Furnishing and Erecting Sheet Metal Work for the Power Station, Lower Cherry River Power Development." Bids were received December 20, 1916, and the contract awarded December 22, 1916, to the Asbestos Protected Metal Company in the sum of \$2150. The contract provides for the completion of this work by February 26, 1917, or ten days after the completion of the building framework. The contract includes, besides the



Intake Chamber and Screens, Lower Cherry Power Aqueduct.

covering of the power house building proper, the sheet metal work for a small oil house.

All the material has been delivered but not yet erected.

Contract No. 23: "For Furnishing and Delivering 7½ ton, hand-operated Crane for the Power Station, Lower Cherry River Power Development." Bids were received February 19, 1917. Contract was awarded February 21, 1917, to Cyclops Iron Works in the sum of \$775. The crane has been shipped to the power house and final payment is ready to be recommended.

Contract No. 24: "For Furnishing and Delivering Electric Line Transformers." Bids were received April 9, 1917, and the contract awarded April 11, 1917, to Moloney Electrical Company for the sum of \$25,347. Delivery has not yet been made.

PROPOSED CONTRACTS

Contract No. 25: "For the Construction of Tunnel Aqueduct in the Mountain Division of the Hetch Hetchy Project." Specifications are well along toward completion and it is expected that proposals will be received in August.

Contract No. 26: "For the Construction of Transmission Line and Substations, Lower Cherry River Power Development." Specifications are being prepared and bids will be received for this work in September.

Contract No. 27: "For Furnishing and Delivering Three Mikado Type Locomotives." Specifications are being prepared and it is expected that proposals will be received in August.

CONTENTS

	Pages
Letter of Transmittal.....	1
District Map of San Francisco.....	5
Population, Area and Assessed Valuation Chart.....	6
Boulevard System	7
Regrades	25
Bernal Cut	31
Cumberland, Noe, Sanchez Streets Improvement.....	33
Leavenworth and Chestnut Streets Improvement.....	35
Bridges	38
Street Pavements	40
Contract Expenditures	50
Municipal Railways	54
Twin Peaks Tunnel.....	80
Sewer System	90
Auxiliary Water Supply.....	94
Surveys	95
Testing Laboratory	98
Photograph and Blue Print Department.....	101
Garbage Disposal	103
Hetch Hetchy Water Supply.....	109

ANNUAL REPORT
OF THE
Bureau of Engineering
OF THE
Board of Public Works

City and County of San Francisco

FOR THE
Fiscal Year ending June 30, 1918

M. M. O'SHAUGHNESSY
City Engineer

Annual Report of the City Engineer 1917-1918

CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BUREAU OF ENGINEERING

San Francisco, January 2, 1919.

To the Honorable

The Board of Public Works of the
City and County of San Francisco.

Gentlemen: Herewith is transmitted the annual report of the Bureau of Engineering for the fiscal year 1917-1918.

Despite the world war and the consequent difficulty in prosecuting construction work, notable advances have been made during the past year on the Municipal Railways, the Hetch Hetchy Project, the Boulevard System, Streets and Pavements, and the Sewer System of San Francisco.

Outer tracks for the Municipal Railways have been laid on Market Street from the Ferry to the portal of the Twin Peaks Tunnel, and through the Tunnel to the districts beyond. By this addition to the system, street railway traffic conditions have been materially improved, and rapid transit provided to the territory west of Twin Peaks, which is very desirable for homes and whose development has heretofore been

handicapped by lack of adequate transportation facilities. The congestion at the Ferry has been relieved by the relocation of tracks leading into the loop, the installation of a cross-over from the inner to the outer loop tracks, and the construction of a third loop on the Embarcadero. Other improvements were made in the Municipal Railway System, which are described in detail in the report.

On the Hetch Hetchy Water Supply satisfactory progress has been made, despite the difficulty in disposing of the bonds and the consequent curtailment of expenditures.

The Mountain Division of the Tunnel Aqueduct is being constructed from three headings, by day labor, under the direction of the City Engineer, at a price considerably lower than that bid by contractors for the same; the Hetch Hetchy Railroad is being operated as a common carrier; surplus power from the Early Intake power house is being sold at a net profit of approximately \$8,000 per month; Lake Eleanor Dam was completed with remarkable speed, and the Project is now in such condition that \$600,000 monthly can be expended efficiently in rushing it to completion when bonds are sold and this money is made available to the Board of Public Works by the Supervisors.

The Hunters Point Boulevard, which affords an excellent avenue for traffic from the Bay Shore Boulevard to the Hunters Point dry dock, was regarded both by the City officials and the Federal authorities as a war necessity, and work thereon was therefore rushed to completion during the past fiscal year.

Considerable construction was also done on the Marina Boulevard, which, inasmuch as it connects Fort Mason to the Presidio, was regarded as of strategic importance.

Work on the Sewer System included the construction of Jackson Street Outfall, Stanley Street sewer, Commercial Street sewer, Trocadero sewer storm relief outfall

for Lake Street, Seventh Avenue sewer extension, and several minor improvements.

Much necessary work has been deferred during the period of the war, but on the termination of hostilities it is desirable that construction on all contemplated projects be advanced as rapidly as possible, in order to meet the growing demands of the municipality. Incidentally, a vigorous construction program by all municipalities is strongly recommended by the Federal Government, to meet the exigencies of the discharge of the American Expeditionary Forces.

Respectfully,

M. M. O'SHAUGHNESSY,

City Engineer.

MUNICIPAL RAILWAYS

Present Status of Street Railway systems in San Francisco

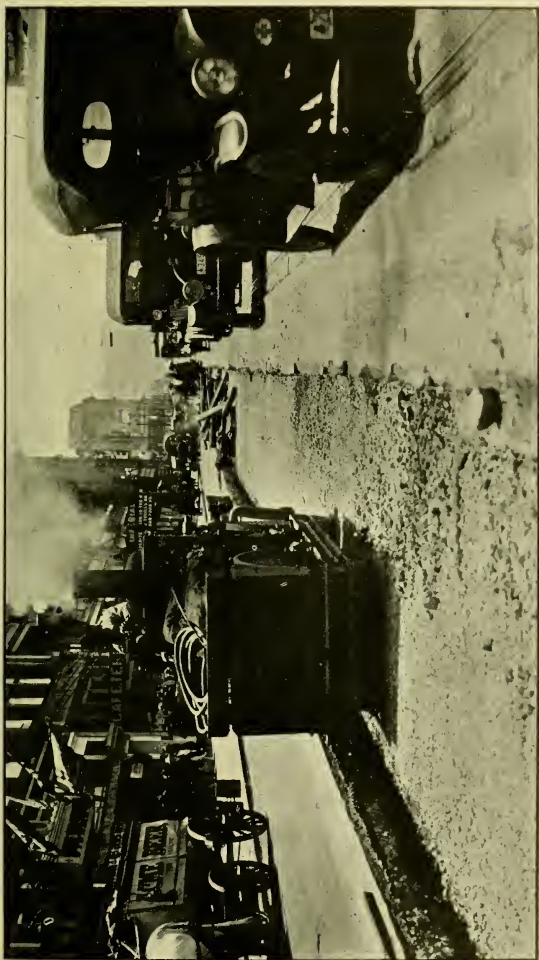
Street Railway transportation in San Francisco is handled by three separate systems, each under separate management and control. The combined total single track mileage of the three systems operating in the corporate limits of the City is 326.6, of which 301.5 miles are electric trolley operated and 25.1 miles are cable operated lines. Originally the mileage of cable operated lines was much greater but following the fire and earthquake of 1906 many of the cable lines were reconstructed as electric lines, the use of the cable only being adhered to where the steepness of the grades prohibited the adoption of the cheaper method of operation.

California Street Cable Railroad System:

The California Street Cable Railroad Company is the smallest of the three systems. It operates three lines all of which are cable propelled, the California Street line 2.86 miles, the Hyde and O'Farrell line 2.10 miles and the Jones Street lines .32 miles, a total of 5.28 miles of double track or the equivalent of 10.56 miles of single track.

The Company operates a total of 38 cars, 19 on the California Street line, 17 on the Hyde and O'Farrell, and 2 on the Jones Street line. These cars are approximately 35 feet in length weigh in the neighborhood of 11,500 pounds and have a seating capacity of 34 passengers; they are open at both ends with a closed center section and are designed for operation in either direction using one grip.

The track is 3' 6" gage, with 3½", 55-lb. grooved rails laid as in cable construction in steel yokes. The track and roadbed is well constructed and is maintained in excellent condition. The maximum grade is 21.3 per cent on Hyde Street, between Francisco and Bay Streets.



Compacting roadbed for Four Tracks on Market Street

On the California Street Line a maximum grade of 18.2 per cent occurs between Grant Avenue and Stockton Street.

The system enjoys a splendid patronage, and owing to the steep hills has been spared the losses from jitney competition that lines in the more level populous districts have been subjected to. The system serves a well built up residence section of the City, a large portion of which is devoted to high class apartments, it connects these residence districts with the banking and commercial districts and the Ferry through the California Street Line and with the retail shopping and theater district through the O'Farrell and Jones Street Line. The proportion of short trip riders is probably larger on this system than on any other in the west, the steep hills making a strong temptation to ride, which is readily yielded to by the residents of these prosperous districts.

The California Street Line was the first of the system to be built being constructed and operated under a franchise originally issued by the Board of Supervisors for a period of 25 years from June, 1876. This original franchise extended from Kearny Street to First Avenue. In February, 1879, however, the Company was permitted to abandon that portion of the franchise between Presidio Avenue, then Central and First Avenue for cable road construction and to construct and operate thereon a steam dummy line with the privilege of later converting this to a cable line. In November, 1879, the period of this franchise was extended to 50 years from February 17, 1879.

The cable road was never constructed west of Presidio Avenue, but this section was operated as a horse car line until the Cliff House and Ferries Railroad Company commenced operation over California Street to 33rd Avenue and to the Beach, when arrangements were made for a transfer exchange at Presidio Avenue and the horse car operation to 1st Avenue was abandoned.

Franchises for the Jones Street Line and the Hyde

and O'Farrell line were granted in 1889. These provided also for the extension of the California Street line to Davis Street. The term of these franchises is such that they expire in 1929 simultaneously with the original California Street grant.

This condition is in marked contrast with the franchise expirations of the various lines of the United Railroads system, and simplifies very much the disposition of the property at the franchise expiration should the City not elect to purchase the system prior to that time.

United Railroads System:

The United Railroads is by far the largest of the three systems, operating 256.6 miles of track within the City's corporate limits and 31 miles in San Mateo County. Of the trackage operated in San Francisco, 14.6 miles are operated by cable and the balance by overhead electric trolley.

The United Railroads of San Francisco was incorporated March 4, 1902, bringing under one control the following Railway Companies, with the track mileage indicated:

Market Street Railway Company.....	176.39 miles
S. F. & San Mateo Electric Railway Co.....	29.36 "
Sutter Street Railway Company.....	12.86 "
Sutro Railroad Company.....	10.34 "

Total	228.95 miles
-------------	--------------

This left only as independent lines the following:

California Street Cable R. R. Co.....	10.56 miles
Presidio and Ferries R. R. Co.....	15.26 "
Geary Street, Park & Ocean R. R. Co.....	14.29 "

Total	40.11 miles
-------------	-------------

and of these the franchise of the Geary Street line expired in 1903.

The Market Street Railway Company absorbed by the United Railroads of San Francisco had been incorpor-

ated in 1893 for the purpose of consolidating a number of independent lines or systems.

This history of these independent lines is really the history of street railways in San Francisco. The pioneer street railroad Company was The San Francisco Market Street Railroad Company incorporated in 1857, which constructed its tracks along Market Street from California Street to the Mission Dolores under the first franchise granted by the City. It commenced operation in 1860 and the cars were operated on a half hourly schedule, being drawn at first by steam dummies but later by horses. Three years later this line was extended to the water front and to 25th and Valencia Streets.

Following the inauguration of this service a number of new companies were formed, notably the Omnibus Railroad Company, which commenced operation in 1863 under franchises following closely the routes of the original omnibus service, the North and South Beach Railroad Company, the San Francisco City Railroad Company, the Central Railroad Company, the City Railroad Company, the Potrero and Bay View Railroad Company, and the Front Street, Mission and Ocean Railroad Company. With the exception of the last named, all these Companies or their successors later were absorbed in the Market Street Consolidation.

These Companies were all formed, the franchises secured and the roads constructed in the days of the steam dummy and the horse drawn car. Naturally the franchise routes followed the routes of easiest travel developed by the earlier stages or omnibuses as closely as the grades would permit, as a result many of the routes were more or less tortuous.

The Clay Street Hill Railroad Company, a cable line which in 1873 commenced operation on Clay Street from Kearny to Leavenworth, ushered in a new era in Street Railway operation. The road was later extended to Van Ness Avenue. This was the first cable operated line in

the world, and it continued in operation with its peculiar little cable dummies until the road was reconstructed and absorbed as a part of the Park and Cliff House Railroad Company. This Company together with the Powell Street Railway Line was almost immediately taken over by the Ferries and Cliff House Railroad Company. The Geary Street, Park and Ocean Railroad organized in 1877, was the next company to adopt the cable operation. This Company, however, maintained its independent operation until its franchise expired and the road was finally abandoned to be rebuilt as the first municipal railroad. The Market Street Cable Railway Company was granted its Market, Valencia, McAlister, Hayes and Haight Street franchise in September, 1879, but did not begin work until June, 1882. In July, 1882, the Haight Street Branch was begun and both were finished during the following year. The Sutter Street Railroad Company, after running for nine years commencing with 1865 as a horse car line, fell in line as a cable road in 1876, at which time it secured a franchise running to 1888; this was, however, in 1879 extended for a period of 50 years. The invention of the cable road which brought attractive hill sites into use had a stimulating influence in the development of San Francisco as it enabled the operation of cars over grades which were prohibitory for any other practical mode of railway operation, and many of these early cable lines are of necessity continued in operation at the present time.

The application of electric power for the propulsion of street railway cars marked the next epoch in their development. The first electric road operated in San Francisco was the San Francisco and San Mateo Railroad Company which ran from Steuart and Market to the County Line via Steuart, Harrison, 14th, Guerrero and San Jose Avenue. This was followed in 1895 by the so-called Sutro line, which was operated to the Beach from the end of the Sutter Street line via California and Clement Street.

The development of electric railway transportation in San Francisco was delayed on account of the conditions contained in many of the original franchises which were granted prior to the development of a practical electric system for street car operation which were of such nature as to prohibit the use of this form of motive power. The requests of the United Railroads Company for permission to change a number of its lines from cable operated to electric operated was before the Board of Supervisors prior to 1906, but had not been granted. The fire and earthquake in April, 1906, put out of commission practically for a time at least all street railway service in the City and brought about the passage of an amendment to the franchises permitting the cable roads to be reconstructed as electric roads where practical, which was accomplished between 1906 and 1907.

Owing to the growth of the United Railroads Company by absorption and consolidation a very serious and peculiar condition exists as regards the franchise life of the various roads and parts of roads forming this system. In 1879, immediately prior to the adoption of the new State Constitution, practically all of the then existing street railway companies availed themselves of the opportunity and had their franchises extended for 50 years, which was the maximum life for which a franchise could be granted under the constitution. As a consequence there are approximately 115 miles of franchises which expire in 1929, 11 years from now.

From 1929, when the next expiration of franchises occur, various mileages expire from year to year until 1947, which is the date of expiration of the last of the United Railroads' franchises. Thus in 1930 there are 11 miles expiring; 1931, 10.85 miles. The next year in which mileage of any extent expires is 1936, when 8.83 miles expire. In 1940 there are 28 miles expiring, in 1941, 9.6 miles; in 1942, 13.4 miles, and in 1944, 7.8 miles.

After the year 1929 there will be a number of broken

or fragmentary franchises remaining, which will be unoperable as units except over the previously expired franchise routes. It is obviously essential that if some arrangement is not made by 1929, by which the City shall take over the United Railroads' lines, the United Railroads will have to be permitted or required to continue the operation of the severed lines over the expired franchise routes on a rental basis, for it is incomprehensible that operation in these districts shall cease with the expiration of these franchises.

The following statistics relative to the operation of the United Railroads' system are of interest and are based on recent general average conditions:

Approximate mileage of single track.....	286
Passenger car mileage per annum.....	22,000,000
Passenger car hours per annum.....	2,500,000
5c fares carried, per annum.....	150,000,000
Transfer passengers carried per annum.....	62,000,000
Gross revenue approximately dollars per annum.....	\$7,500,000
Revenue per car mile, dollars.....	.341
Revenue per car hour, dollars.....	3.00
Operating expenses, dollars per annum.....	\$5,000,000
Operating expenses per car mile.....	.227
Operating expenses per car hour.....	2.00

The United Railroads employs approximately 3,000 men, and pays approximately three million dollars a year in salaries and wages. It owns about 700 electric passenger cars.

The United Railroads' gross earnings in 1913 and 1914 were in excess of eight and one-half million dollars. Since that time they have fallen off materially, due primarily to jitney competition, so that for the year 1916 the gross operating revenue in the neighborhood was only \$7,320,930.00. The Company has not recovered from the effects of the strike of 1917 which still further reduced the revenue. The earnings are now increasing, however, and should continue to increase constantly. The future of the company after 1929 is dependent largely upon the

attitude which the City may adopt in handling the conditions which will arise at that time if the properties are not purchased by the City prior to these franchise expirations.

Municipal Railway System :

The history of the Municipal Railway System really dates from the adoption of the Charter of the City and County of San Francisco which was ratified by a vote of the people in 1898, approved by the Legislature January 26, 1899, and went into full force and effect January 8, 1900. In the first paragraph, Article 12 of the Charter, the following intention is set forth: "It is hereby declared to be the purpose and intention of the people of the City and County that its public utilities shall be gradually acquired and ultimately owned by the City and County."

The first street railway franchise to expire after the adoption of the new Charter was that of the Geary Street, Park and Ocean Railroad Company. This occurred November 6, 1903. The Geary Street Company had applied in 1896 and 1898 for an extension of franchise for a period of 50 years. It appears that the effort was successful as far as the Board of Supervisors was concerned, but evidently the renewal or extension of franchise was attacked in the Courts, where it was decided that an extension of franchise could not be granted prior to one year before its expiration. Another effort in 1903 to extend the franchise again failed.

Following the expiration of the franchise the Company continued to operate the road on a temporary month to month permit for which privilege they paid into the City Treasury 5% of the gross revenue. This continued with occasional interruptions and modifications until May 5, 1912, when the road ceased operations.

During this period several efforts had been made looking to the taking over of the road by the municipality.

On December 2, 1902, a proposition authorizing \$700,000.00 worth of bonds for the purchase of the Geary Street road and its reconstruction as an underground electric conduit railway was submitted to the people but was defeated. The vote cast was 26,612, of which approximately 15,000 were for the bonds, but short however of the necessary two-thirds. On October 8, 1903, a second election was held, this time calling for a \$710,000.00 issue of bonds. This met with the same fate as the first election, the vote polled being 25,276, with about 14,000 votes in favor of the proposition. In 1905 the Board of Supervisors made a budget appropriation of \$325,000 for the purpose of acquiring and reconstructing the property, plans and specifications were prepared for the work and the necessary preparation made to go ahead when the fire and earthquake of 1906 occurred and prevented further action. The money appropriated for the railroad work and not used was transferred and used for the reconstruction and rehabilitation of streets and buildings, the Geary Street Company rehabilitating the road and continuing its operation.

The year following in June, 1907, a budget appropriation of \$720,000 was made for the purchase and reconstruction of the line. This was subsequently declared invalid by the courts. A third bond election on a proposition authorizing \$1,950,000 of bonds was submitted to the people on June 24, 1909. This failed of carrying the necessary two-thirds majority by 203 votes, the vote being 14,404 for and 7805 against. The advocates of municipal ownership were so much encouraged by the results of this election that two propositions calling in the aggregate for \$2,020,000 of bonds were submitted at a special election December 30, 1909. Both propositions were carried, the first for the construction of a municipal line from Kearny Street to the Ocean Beach calling for \$1,900,000 carried 31,151 to 11,704, the second for the

construction of tracks from Kearny Street to the Ferries calling for \$120,000 carried 30,869 to 11,613.

The Lower Market Street and the main Geary Street propositions were kept separate in the bond issue to avoid the possibility of delay, which might occur in event that the legality of the City's right to construct the tracks on Market from Kearny to Sansome was questioned and the matter taken to court. The legality of the bond issue was tested and their validity established by a decision of the Supreme Court in July, 1910.

These Geary Street and Lower Market Street bonds bear $4\frac{1}{2}\%$ interest, they mature serially between 1915 and 1934 at the rate of \$101,000 per year, and are a direct lien against the City. In July, 1910, the first lot of \$121,000 bonds were sold and preparations were made for the reconstruction of the old Geary Road which ceased operation on May 5, 1912, when the last cable car was run over the road. Construction of the road was started by day labor under the direction of the Board of Public Works in 1911. This did not prove satisfactory and the road was completed by contract. The first section of the line was put into operation December 28, 1912, from Kearny Street to 33rd Avenue.

The City had contracted for the construction of 43 cars with a local firm, notwithstanding that an eastern firm was the lowest bidder. This was done under the policy of favoring "home industry." The result was that while the cars were under construction the local firm which was building them failed and the delivery of the cars was delayed. Finally the Union Iron Works was called in and took over the contract and completed the cars at the request of his Honor, Mayor Rolph.

On June 24, 1913, the road was placed in full operation from the Ferries to the Beach with 28 cars, the track having been extended from 33rd Avenue to the Beach under one contract and from Kearny to Sansome on

Market Street under another. At Sansome and Market Streets the Municipal tracks were connected with the then existing outer tracks of the Sutter Street Railroad on Market Street under the terms of what is known as the Lower Market Street Agreement, which was entered into and approved under a referendum election held April 22, 1913. Under this agreement the City purchased a half interest in these outer tracks from Sansome to the Embarcadero at its physical value and secured the right to use the Ferry loop, the United Railroads agreeing to furnish the power for propulsion of cars at cost or at such lower rate as the City might itself secure elsewhere, the maintenance of the tracks being divided equally.

The lower Market Street agreement was entered into as a compromise, the City following the refusal of the Sutter Street Company to allow the use of the outer tracks for the Municipal cars had secured a judgment declaring the franchise for these tracks to have become invalid for violation of the franchise provisions, and the Company on the other hand having taken the matter to the Supreme Court on appeal was in a position to indefinitely delay the operation of the Municipal cars to the Ferry, and further, the terminal loop at the Ferry, which was on State property, was owned by the Company.

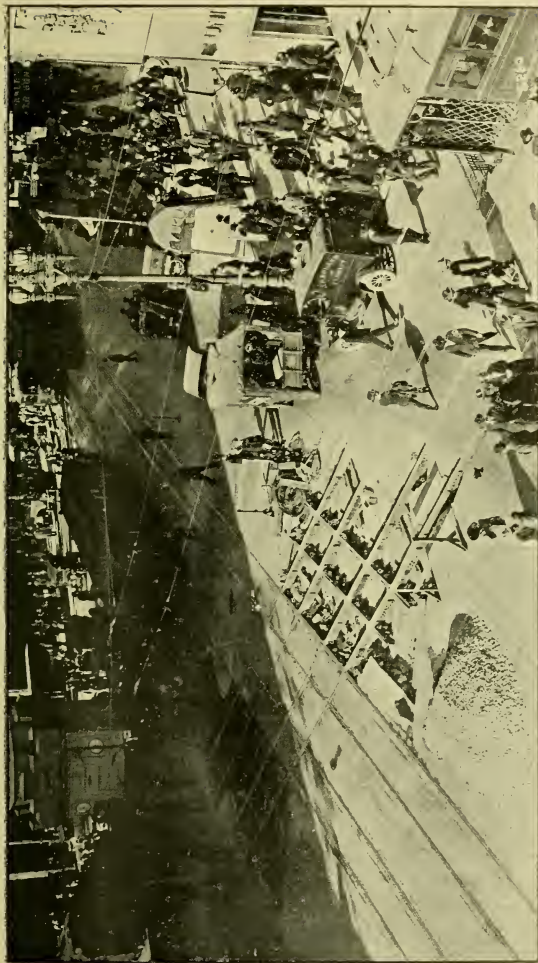
Under the original Bond Issue of December 30, 1909, the City constructed 7.1 miles of double track, complete with overhead; acquired half interest in 2300 feet of double track on Market Street; constructed a reinforced concrete Car Barn with a capacity of 64 cars, which was later enlarged to accommodate a total of 132 cars including space for 8 cars in the paint shop and 12 in the repair shop; this barn also houses the repair shops and the railway offices, and contains space for an electric substation; purchased 43 semi-steel cars, equipped with 4 60 H.P. Motors, seating 48 passengers, and purchased a site for a steam driven electric generating station.

About the time that the Geary Street Railway was placed in operation, the problem of providing steel Railway transportation to the Panama Pacific Exposition at the Marina was presented to the Municipal authorities, the United Railroads having taken a positive stand that they would not construct another foot of track in San Francisco under the franchise restrictions of the existing Charter. Confronted with these conditions, upon the request of the Directors of the Exposition, the Board of Supervisors requested the Board of Public Works to submit plans and estimates of cost of street railways designed to furnish the Exposition with adequate service, and at the same time form a nucleus for a Municipal Railway System.

In response to this request the City Engineer on April 5, 1913, submitted to the Board of Public Works for transmittal to the Board of Supervisors a "Report on Extensions of Municipal Railways to Provide Transportation for the Panama-Pacific Exposition." On the basis of this report there was submitted to the people at a special election on August 26, 1913, a proposition to provide \$3,500,000 by a bond issue to construct and equip some 12½ miles of double track road and to purchase the Presidio and Ferries system with its 3.9 miles of double track.

This bond issue was overwhelmingly carried by a vote of 51,452 for and 13,782 against. These bonds bear 5% interest, and are redeemable serially at the rate of \$100,000.00 per year commencing December 1, 1918.

The opening of the Exposition was set for February 20, 1915, leaving only 18 months from the date of the Bond Election for the completion of the roads. The money from the sale of bonds was not available until January 1, 1914, four months later, and as time was at a premium, money was advanced from the earnings of the Geary Street Road for the preparation of plans and specifications and the making of the necessary surveys. It was



Crossing at Market and Third Streets, Installed in 8 Hours



Constructing North Track, Market, near Fulton Street

not possible, however, to enter into any contracts for material prior to January 2, 1914, owing to a charter provision which requires that the actual money must be in the Treasury before a contract may be entered into. However, by having the specifications prepared in advance it was possible on January 2nd to award contracts for \$871,811 worth of material, which covered all of that immediately necessary for the construction and equipment of the roads.

In the campaign for the bond election, the arguments used against the bonds was that it was impossible for the City to construct and equip the contemplated mileage in time to serve the Exposition. This was the most difficult argument to overcome as the opponents pointed to the three years that had elapsed between the Geary Street Bond Issue and the placing of that line in operation. In his report the City Engineer stated that the roads could be completed within 20 months after the money was available.

The construction of these lines while not involving any unusual difficulties from a physical standpoint, still considering the magnitude and variety of the work, and taken in conjunction with the red tape which hedges in municipal work and the possibilities of delays due to political activities, it became a real problem to place the lines in service before the opening of the exposition.

To insure as far as possible the coordination of all work, the entire construction program was developed and plotted up graphically. The construction program showed all of the material and construction contracts required for the completion of the extensions contemplated, the dates at which each of the contracts had to be awarded, the dates when work on each had to be commenced, and when completed. This program was submitted to the Board of Supervisors and it was impressed on them that the program planned could be carried out but only with their cooperation, and that any delay which occurred in

departing from recommendations of the City Engineer would not be burdened by that official.

All essential contracts both for materials and construction work were prepared with carefully worked out bonus and penalty clauses, the time for the performance of the work was fixed so that with reasonable effort the contractor could readily earn the full bonus (which was generally limited to 30 days) for the early completion of the work. The idea being that all bidders in figuring their bids would count on winning the full bonus and discount their prices accordingly. Having discounted the bonus in order to earn the full amount contemplated in submitting the bids, it was necessary for the contractors to finish the work in time to earn the full bonus, and a failure to do this automatically imposed a prepaid penalty. This worked out splendidly and in nearly every case the contractor earned the bonus and the various contracts were completed so as not to affect other dependent work.

The first contract for track construction to be awarded was for the Van Ness Avenue and Chestnut Street Line. Actual construction was begun on April 6, 1914. The contractors were the Mahoney Brothers who had constructed a portion of the original Geary Street Line. This contract was completed on schedule time and was placed into full operation on August 15, 1914, a little over 8 months from the time that the money was first available. The second line to be constructed was the Potrero Avenue Line, really an extension to the Van Ness Avenue Line—the contractors for which were Eaton & Smith. This line was completed and put into full operation with the Van Ness Avenue Line on September 7, 1914. Following this the contract for the Stockton Street, Columbus Avenue and Fort Mason lines was awarded to F. Rolandi on June 5, 1914. A section of Stockton Street Line on Stockton Street between Sutter and Sacramento running through the Stockton Street Tunnel was let as a separate contract to Eaton & Smith, August 28, 1914.

The track work through the tunnel was completed practically simultaneously with the completion of the Stockton Street Tunnel, and the Stockton Street and Columbus Avenue lines were placed into full operation on December 29, 1914. The California Street Line, which was planned to have been constructed and completed January 1, 1915, was delayed owing to the failure of the Board of Supervisors to dispose of the necessary bonds at a time when they were salable, no bids for the same being received at the next offering. However, sufficient bonds were sold over the counter to permit of the contract being entered into on December 14, 1914. The line as far as 13th Avenue was completed and put into operation February 19, 1915, the day before the Exposition opened, and on 33rd Avenue, March 28, 1915.

In the Annual Report of the Bureau of Engineering for the Fiscal Year ending June 30, 1916, there was presented a detailed chronology of the public proceedings incident to the construction of the Church Street Line. However, a brief reference to some of the difficulties met with may not be amiss here.

The bond issue of 1913 provided for the construction of a line from Market Street and Van Ness Avenue over connecting streets to Church Street and thence over Church Street to 30th Street. The report of the City Engineer and the preliminary plans discussed in the campaign for the bond issue called for the opening of a new street, with vehicular roadway and sidewalks, diverting through Mission Park from 18th to 20th, and through private property from 20th Street to 22nd Street; thereby avoiding the prohibitive maximum grade of 19.2% on Church Street. This new street to be opened as an assessment project as it would greatly improve property value. When it came to forming the assessment district a number of the people residing in the Church Street Hill Section banded together in what was known as the Church Street Non-Assessment League, and influenced the Board

of Supervisors to such an extent that they agreed to provide a right of way for the street railway free of cost to property owners, thus throwing an added expense of approximately \$100,000 on the bond issue work. The plan for overcoming the grades as finally approved was the original plan recommended by this office but without the vehicular roadway and sidewalk. Its adoption was not accomplished, however, without a great deal of wasted time, money and effort. In passing it may be briefly stated that this office was required to prepare plans and estimates covering not less than 13 different schemes for overcoming these grades. The most absurd of these plans was one recommended by a private engineer employed by the Non-Assessment League and for which the Board of Supervisors ordered the City Engineer to prepare plans and specifications. This contemplated the operation of the electric cars over the Church Street Hill with the assistance of a power operated cable installed in the usual cable road manner. Carrying out these explicit instructions this department prepared plans and specifications for a cable road to be operated over the Church Street Hill and transmitted the same to the Board of Supervisors through the Board of Public Works with the recommendation that the plans be **not** adopted. After much discussion,* not without bitterness, a majority of the Supervisors became convinced of the folly of the plan and it was discarded and San Francisco was saved from a lasting monument to political engineering. The construction of the Church Street Line was very seriously delayed by the Supervisors not acting on the advice of this office as to the portion of the line which should be built first. The construction of the line on Market Street involved certain legal questions covering the right of the City to construct parallel tracks, and it was known action taken would be contested by the United Railroads. In order that this question might be entirely disposed of at the earliest date, the City Engineer recommended that

the construction of the Market Street portion of the line be undertaken first. This recommendation was rejected by the Board of Supervisors who would not consent to the construction of this portion of the line until the wrangle as to the route on Church Street had been disposed of, with the result that when the Church Street plan was agreed upon, and the work authorized and completed, the Market Street portion of the line was still held up by injunction.

The right of the City to construct its tracks on Market Street was established by a sweeping decision of Judge Wm. H. Hunt of the U. S. District Court, on January 18, 1917. This cleared the way for the construction of the Church Street line with outer tracks on Market Street and this work was pushed to an early completion and operation as far east as Van Ness Avenue was commenced on August 11, 1917.

Commencement of operation of the Church Street Line marked the completion of the work contemplated under the 1913 Bond Issue.

In addition to the construction of 12.5 miles of double track and the purchase of the Presidio and Ferries system with 3.9 miles of double track the City purchased a car house site, 200'x400', and constructed a car barn at 17th and Hampshire Streets, and purchased 125 new passenger cars.

The car barn of reinforced concrete was built by the Clinton Construction Company. It is one story in height and covers 200'x380' of the above lot. The building is designed to be increased to a two-story structure with a capacity for 94 cars on each floor. The entrance of the first floor is from a ladder track on 17th Street, while the entrance to the second story will be from Mariposa Street, advantage having been taken of the natural difference of elevation of these two streets to build a two-story car barn with both floors at street level. The first story only has been built, the floor of the second story serving as a

temporary roof in which provision has been made for future storage tracks with pits.

The cars purchased by the City for service on these extensions were designed in this office. Separate contracts were awarded for the car bodies, the electrical equipment, the trucks and the air brake equipment. These contracts originally covered parts for but 100 complete cars and carried the privilege of purchasing additions up to a total of 125. This privilege was exercised and the City purchased the full number. The bodies and equipment were shipped to the City's yard at 6th and Hubbell Streets where by means of a gallows frame and tackle they were unloaded and assembled.

The cars are 47' 1" over all, 9' 2" in width with a seating capacity of 50, and weigh complete 48,000 pounds. Under conditions of extreme loading 170 passengers at once have been handled on them. Comparing them with the Arnold cars purchased for the original Geary Street road they are 6" wider, seat 2 more passengers, carry 30 more passengers under extreme loading and weigh 2000 pounds less. The bodies were built by the Jewett Car Company at Newark, Ohio, and are of the California type with open ends and closed center compartment. The construction is semi-steel, finished with cherry wood and exposed natural finished white cedar roofing; head lining not being considered necessary in this climate.

The electrical equipment of these cars was furnished by the Westinghouse Electric and Manufacturing Company and consists of 4 of their 306 C. A., 600-volt, 60 H. P. Motors with type H. L. control.

The trucks, two to each car, were furnished by the Baldwin Locomotive Works, and are of pressed steel with 34" rolled steel wheels and outside hung motors.

The air brake equipment was furnished by the Westinghouse Traction Brake Company and is the straight air type with automatic emergency valve.

The contracts for the cars and equipment were awarded January 2, 1914, the body contracts providing for the delivery of 25 car bodies at Newark within 210 days after the signing of the contract and 25 bodies every 30 days thereafter until the contract was completed. The usual bonus and penalty clauses were included and the delivery of the electric and other equipment was coordinated to that of the car bodies. All cars and equipments were delivered in advance of the contract schedule of deliveries, thereby earning the full bonus in each case. The first twenty-five cars were placed in operation August 14, 1914, when the Van Ness Avenue Line was opened for service.

Up to the time of the completion of the Church Street line all of the Municipal Street Railway development had been from funds provided by the two bond issues of 1909 and 1913. All extensions to the system since then have been built from the surplus earnings of the bond issue lines.

The first of these extensions was on Potrero Avenue from 25th to Army Street, .22 miles of double track, constructed under contract by Eaton & Smith, and placed in service December 21, 1917. This short piece of line was built at the time of opening a new street as an extension to Potrero Avenue, in order that the pavement in the tracks could be laid with the original street surface, saving thereby approximately \$6000.00 over the cost of installing the track after the completion of the street pavement.

The next line to be built was the Twin Peaks Tunnel Line, connecting with the Municipal Railway tracks on Market Street at Church Street, and extending out Market Street to 17th and Castro Streets, thence through the Twin Peaks Tunnel to the junction of Sloat and Junipero Serra Boulevards. This line was built under two contracts but by the same firm, Eaton & Smith. The first contract covered the construction of the outer tracks on

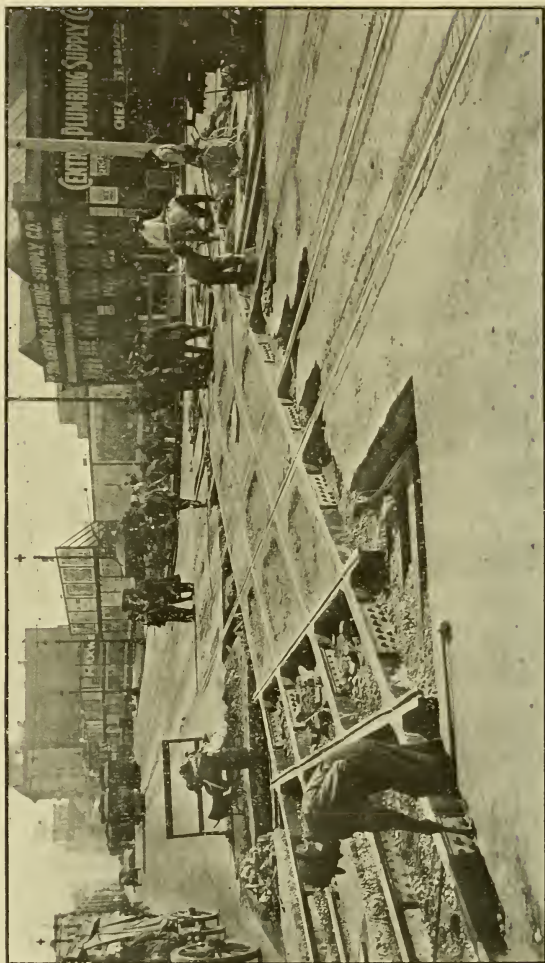
Market Street from Church Street to the east portal of the tunnel, a distance of .48 miles. The second contract extended from the east portal of the tunnel to Sloat Boulevard 2.83 miles. The line was placed in operation February 3, 1918, operating through the Tunnel along Market Street to Van Ness Avenue and over Nan Ness Avenue to a terminal at Bush Street, 3 blocks north of Geary Street. The preliminary proceedings before the Board of Supervisors leading to the final determination of the City to build this Tunnel line were attended with nearly as much discussion and feeling as surrounded the building of the Church Street line.

The Twin Peaks Tunnel, 12,000 feet in length, had been contracted for in November, 1914, with the expectation of having it completed during the latter part of 1917. This project involving the expenditure of approximately \$4,500,000 was undertaken for the purpose of providing transportation to the large district west of the Twin Peaks, comprising approximately 4000 acres of desirable home sites, otherwise practically isolated from the business section of the City by prohibitive grades. The money for this entire project was provided by assessment on the property to be benefited, 85% being from the district west of the Peaks. At the time this project was initiated there was no definite plan as to what cars were to use the Tunnel or how they were to be routed. The United Railroads Company, in the so-called Parkside lines, had the nucleus of a railway system for this outlying district which when considered in connection with their Castro Street line, operating on Market Street from the Ferries to the easterly portal of the Tunnel, placed them in a strategic position to accept such advantage as might accrue from the operation of cars through the tunnel. This office, early recognizing the necessity of a definite plan for railway service to the West of Twin Peaks Tunnel, had, in a report to the Board of Supervisors under date of December 7, 1915, pointed out the importance of

this problem and its logical solution. Quoting from this report—"While considering this matter of the Church Street Railroad, it would be well to consider at the same time transportation through the Twin Peaks Tunnel for the questions at issue are practically the same. The property owners affected are paying approximately \$4,000,000 for the construction of this tunnel and it is common justice that the City should take immediate steps to insure the construction and operation of a street railway through the tunnel upon its completion."

"Transportation for the entire districe west of Twin Peaks will be principally dependant on the Twin Peaks Tunnel and the logical method of handling this transportation will be for the City to own and operate the entire street railway system in this district. It is suggested that an agreement be entered into with the United Railroads for the purchase of their tracks on Sloat Boulevard from Junipero Serra Boulevard to the Great Highway, on 19th and 20th Avenues from Sloat Boulevard to Lincoln Way, and in Parkside, and arrange for the exchange of transfers on an equal basis at the easterly mouth of the Twin Peaks Tunnel, at the junction of Junipero Serra and Sloat Boulevards and at the junction of 20th Avenue and Lincoln Way. The 20th Avenue line should then be extended northerly across Golden Gate Park to join the tracks of the Geary Street Municipal Railway."

This report brought forth some discussion and the matter was taken up with the United Railroads' officials who expressed their willingness to enter into such an agreement suggesting a tentative figure of \$500,000.00 for the properties involved. The plan was discussed by the then Public Utilities Committee who expressed themselves as favorably impressed with it but felt that they should pass the entire subject over to the new Committee and Supervisors who would take office the following month. The new Board of Supervisors and Public Utilities Committee, however, did nothing with the report and



Installation of Special Work—11th and Market Sts.



Installation of Special Work—11th and Market Sts. (4 days later)

let the matter drop. War conditions caused a continual rise in the price of materials and extending the delivery periods. While it seemed hopeless to secure an agreement on and the adoption of any general plan for railway service to the West of Twin Peaks, owing to the many conflicting interests and questions of policy, it was clear that someone should begin the construction of the tracks through the Tunnel, and the only way to get them built was to eliminate from consideration all questions of connections and methods of operation and, by concentrating on the construction feature, secure the necessary authority from the Supervisors to prepare the plans and specifications and order the materials necessary for the City to do this work. This recommendation was made to the Supervisors on February 25, 1916, but was not finally passed and approved until June 2, 1916. This delay cost the City several thousand dollars due to advancing prices of the rail and a premium necessary to insure the delivery of the rail in the required time. Meanwhile, some negotiations had been had with the United Railroads relative to the use of 2 blocks of their tracks on Church Street, in which the City had proposed to purchase a half interest. The United Railroads agreed to sell this half interest but refused to allow the City to make physical connection between its tracks and these United Railroads tracks. Following this announcement at a meeting of the Public Utilities on April 6, 1916, Chairman Wolfe announced that the City and the United Railroads had come to the parting of the ways. Shortly thereafter, the Supervisors determined on the policy of paralleling the United Railroads' tracks on Market Street from the Tunnel to Kearny Street and on Church Street from Market to 16th, and this ordinance was passed June 2, 1916. In order to throw the matter into the courts for final settlement, the Board of Works on June 12, 1916, commenced the work of installing a crossing at Van Ness Avenue and Market Street. Whereupon the United Railroads secured a temporary

restraining order from the United States Circuit Court. This suit resulted in the broad decision of Judge Hunt hereinbefore noted as having cleared the way for outer tracks on Market Street.

This decision opened the way for the City to construct a line on Market Street from 17th and Castro, the eastern portal of the Twin Peaks Tunnel, to a connection with the existing Geary Street tracks at Geary and Market Streets, thereby making it possible for the City to operate cars from the Embarcadero over the entire length of Market Street. The Church Street Line was first placed in operation on August 11, 1917, when operation was had from Church and 30th to Van Ness Avenue and Geary Street, and later extended to Van Ness Avenue and Bush Street.

In the meantime the Twin Peaks Tunnel connecting the Sunset District with Market Street was being pushed to completion and plans and specifications had been prepared and contracts let so that on the 14th day of July, when the completion of the Tunnel was celebrated, work was commenced upon the construction of the railway through the Twin Peaks Tunnel. Also specifications and contracts had been let for the construction of the outer tracks on Market Street from Church Street to the east tunnel portal. All of this work was completed and the Twin Peaks Tunnel Line was placed in operation from Van Ness Avenue and Geary Street to Sloat Boulevard and Junipero Serra Boulevards on February 3, 1918.

Contracts for the purchase of the necessary special crossings and track work for constructing the remaining link on Market Street between Van Ness Avenue and Geary Street were let August 13, 1917, and the delivery of this material was not completed until March, 1918. Owing to the importance of this piece of track and the important traffic section of the City through which it had to be constructed, it was decided that no work should be commenced upon this contract until all of the materials

were actually on hand. A most careful study was made, laying out a working schedule which would insure the work being completed with the greatest dispatch and at the same time causing the least inconvenience to traffic on Market Street. The following plan was adopted and prescribed in the specifications: Under the contract the work was divided into two sections: Section "A" comprising the installation of all of the track special work and appurtenances and the payment incident thereto, and Section "B", which comprised all of the work other than that covered under section "A", namely, the installation of the track and repaving of the street. The contractor was given 60 days for each section of the contract, provision being made, however, that Section "B" should not be commenced until Section "A" had been completed. This subdivision of the work had the advantage that the track special work at each street crossing was installed and immediately repaved. The trench on either side of the track special work not being opened, cross traffic merely passed around the special work in either direction. The result was that practically no interference to traffic was occasioned by the installation of crossings.

Each section of the track carried a bonus of 20 days which it was expected that the contractor would earn, cutting down the actual time of construction to 40 days on each section or 80 days on the entire contract. Section "A" of the contract was actually completed in 24 working days and the entire work was completed within 70 days from the time of beginning the work, including some ten days lost time on account of parades, holidays and Sundays. In addition to the division of the work into sections the following precautions were taken to handle the work in such manner as to discommode the public and traffic in the least possible manner: The use of pile drivers and steam shovels were prohibited. The specifications required that between the hours of 7 a. m. and 10:30 p. m. the contractor should maintain an unobstructed traffic

lane not less than 12 feet in width measured out from the curb. This allowed a space of 4 feet adjacent to the track trench in which to store material. The contractor was further required to provide and maintain suitable platforms at all regular stopping places for street cars giving safe and convenient access to and from United Railroads' cars. Temporary crossings were installed and maintained at all other points necessary to care for traffic, especially at intersecting streets. Except in zones designated, the contractor was not permitted to dump rock, sand or other material which might readily scatter. He was prohibited from attempting to haul or deliver materials under circumstances which would involve the interruption of traffic and when required, to deliver such materials between the hours of 10:30 p. m. and 7 a. m. All material excavated from the track trench was required to be loaded directly in conveyances and immediately hauled away. The concrete paving base removed was hauled away from the site and crushed being returned for use as ballast. The contractor was not permitted to open up the track trench on the south side of the street until the rail had been laid and the paving base replaced and the street cleaned up on the north side. By rigidly following this prescribed method of work it is felt that considering the density of traffic, that this piece of work was constructed with less inconvenience to traffic and with less annoyance to adjacent property owners and tenants than any other similar piece of work handled in this City or elsewhere other than New York or London. This line was placed in operation June 1, 1918, permitting direct travel from the Embarcadero through the Twin Peaks Tunnel to Sloat and Junipero Serra Boulevards.

This line with its terminus at Sloat and Junipero Serra Boulevards could be of little benefit to the Sunset District, which with the other adjoining districts by direct assessment paid 85% of the cost of the Twin Peaks Tunnel. When this road was planned it was felt that a con-

nection must be made with the tracks of the United Railroads already serving this west of Twin Peaks District. For several years efforts had been made to effect a solution or an agreement which would permit of the use of these tracks of the United Railroads, namely, out Sloat Boulevard to the Beach and over Ocean Avenue to Harold Avenue, and over 20th to Lincoln Way, and from 20th over Taraval, 33rd, Wawona and 35th to Sloat Boulevard. As already stated, on December 7, 1915, the City Engineer recommended the purchase of these lines from the United Railroads and the United Railroads expressed an willingness to sell them. This recommendation of the City Engineer was not followed up by the Board of Supervisors. Later negotiations were entered into under which the City would be allowed to operate cars over these tracks provided that the United Railroads were permitted to use the City's tunnel tracks on an equal mileage basis. This plan, which was also recommended by the City Engineer, was likewise rejected by the Board of Supervisors. Therefore, on February 3, 1918, when the Twin Peaks Tunnel Line commenced operation, it was necessary to put on buses to connect with the end of this Twin Peaks line at Sloat and Junipero Serra Boulevards to give transit service to some of the more built up portions of the west of Twin Peaks District.

The Municipal Railway has been one of the first railways to adopt motor buses for feeder purposes and for pioneering outlying districts. The first of these bus runs was established across Golden Gate Park from 10th Avenue and Fulton Street to 48th Avenue and Kirkham Street, September 1, 1917. Later this bus route was terminated at 25th Avenue and Irving Street and a separate route established from the end of the Geary Street line at Cabrillo Street to 48th Avenue and Kirkham Street, which has since been extended along the Great Highway to Sloat Boulevard. The other bus routes previously referred to run from the terminal of the "K"

or Tunnel line at Sloat and Junipero Serra Boulevards, over Ocean Avenue to Harold Avenue; also over Sloat Boulevard, 19th Avenue and Taraval Street to 33rd Avenue.

The total mileage of the Municipal Railway system at the present time is 58.8 miles of single track. This mileage was constructed and came into service in the following elements or lines as follows:

Line	Length Single Track	Fund or Bonds	Operation Commenced
B Geary St., Kearny to 33rd Ave.....	9.96	1910	12/28/1912
A 10th Ave., Geary to Golden Gate Park	1.02	1910	12/28/1912
Market Street, Ferries to Kearny.....	1.42	1910	6/24/1913
B Geary Street, 33rd Ave. to Ocean.....	2.74	1910	6/24/1913
E Union Street, Ferries to Presidio.....	7.74	1913	12/11/1913
Masonic Avenue, Geary to Turk.....	.50	1913	5/16/1914
H Van Ness Avenue, Market to Bay.....	4.08	1913	8/15/1914
H Potrero Ave., 11th and Market to 25th and Potrero	4.42	1913	9/7/1914
D Chestnut St., Scott, Greenwich, Stein- er to Union.....	2.66	1913	8/15/1914
F Stockton, Columbus Ave., N. Point.....	4.14	1913	12/29/1914
H Fort Mason Loop.....	.96	1913	12/29/1914
C Calif.St. Line, 2nd Ave.& Geary to 13th 13th Ave. to 33rd Ave.....	4.14	1913	2/19/1915 3/28/1915
B Beach Terminal Loop, Geary St. Line	.12	1910	8/25/1915
J Market & Van Ness to Church & 30th	5.04	1913	8/11/1917
H Potrero Extension from 25th to Army	.44	Earnings	12/21/1916
K Twin Peaks Tunnel Line, Church to Sloat	6.62	Earnings	2/3/1918
D Greenwich Extension, Scott to Baker	.58	Earnings	5/4/1918
Market Street, Geary to Van Ness.....	2.52	Earnings	6/1/1918
	59.10		
Less track on Scott Street between Greenwich and Chestnut Streets which was removed.....	.30		
Net trackage now in use.....	58.50		

Of the 59.10 miles of single track constructed, 15.26 miles were constructed under the 1910 Bond Issue, 33.68 miles under the 1913 Bond Issue and 10.16 miles from earnings. In addition to the above mileage of railroad operated, the following bus services have been established:

	Length Round Trip	Operation Commenced
10th and Fulton to 25th and Irving.....	4 miles	9/1/1917
Great Highway, Cabrillo to Sloat Blvd...	5.24 miles	1/15/1918
West Portal to Harold Avenue.....	3 miles	2/3/1918
West Portal to 33rd and Taraval.....	3.36 miles	2/19/1918

Total length, bus lines.....15.60 miles round trip

Operating statistics of the Municipal System for the last fiscal year ending June 30, 1918, are as follows:

Operated mileage, cars and buses.....	74.40
Passenger car mileage for the year.....	6,636,370 *
Passenger car hours for the year.....	736,295
Bus mileage for the year.....	298,720
Bus hours for the year.....	30,701
Fare paying passengers carried.....	47,668,270
Passengers carried on free transfers.....	13,589,247
Passengers carried on revenue transfers.....	750,026
Employees, Policemen and Firemen carried.....	388,493
* Gross operating revenue for the year.....	\$2,381,104.46
* Revenue per car or bus mile.....	.3433
* Revenue per car or bus hour.....	3.1044
* Operating expenses	\$1,403,699.55
* Operating expenses per car or bus mile.....	.2024
* Operating expenses per car or bus hour.....	1.8301

* The figures are subject to change when final audit is completed.

The average number of employees of the railway is 800 who annually receive approximately \$1,000,000 in salaries and wages. It owns 197 passenger cars, 168 of which are large modern double end, prepayment cars; 1 work car and 5 automobile buses, seating 19 passengers each.

A financial statement of the earnings of the Municipal Railway system from December 28, 1912, to June 30, 1918, shows:

Revenue

Operating revenue.....	\$8,457,792.06
Other revenue, including interest on bonds.....	23,214.74
Gross revenue	\$8,481,006.80

Disbursements

Operating expenses, claims, bond interest and bond redemption.....	\$6,411,721.90
Betterments and additions.....	907,281.04

Reserves

Depreciation fund	\$ 923,456.07
Casualty	35,339.41

Total disbursements and reserves..... **\$8,277,798.42**

Surplus **\$ 203,208.38**

The Municipal Railways have shown a continued healthy growth in revenue and continued popularity. The earnings per car mile have continued to increase and notwithstanding the fact that during the continually increasing prices both for material and labor the money set aside from earnings as a surplus has increased. What the Municipal Railways have done is best realized when it is observed that while the City has constructed and acquired some 48.94 miles of track in the 1910 and 1913 Bond Issues, it has constructed 10.16 miles out of the surplus earnings of the road, and in addition to this has paid the interest on the bonds, set aside \$923,456.07 in its depreciation reserve, \$35,339.41 in its injury insurance fund, and has retired \$303,000.00 of its bonds.

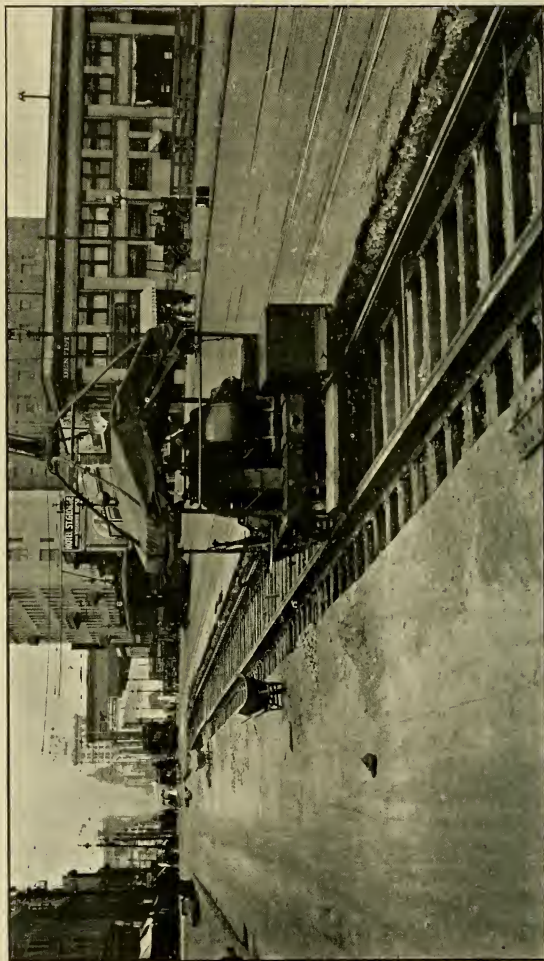
RAILWAY EXTENSIONS

During the year 1912 Bion J. Arnold made an exhaustive study of the transportation facilities in this City

and as a result of that study he reached the conclusion that at that time the growth of the United Railroads' system was 6 years behind the average rate at which that system had expanded between the years 1900 and 1905, which had been at the rate of $6 \frac{2}{3}$ miles of single track per year, which was about 2 miles per year less than the rate of expansion in the preceding 10 years. Between 1905 and 1913 only 8 miles of extensions were added to the property. A study of the needs of the City independently of this fact indicated that 72 miles of single track were needed to be constructed in the following 5 years or by January 1, 1918. He further estimated that in the 5 years, 1918 to 1923, the City's needs would call for a further extension of 50 miles of single track. Mr. Arnold also pointed out that at the time of his report San Francisco was scarcely half-developed and that the expansion of transportation facilities should continue and would be warranted by the necessities of the City. He estimated that some \$18,000,000 in extensions should be made by 1923.

Since Mr. Arnold made his report the City has constructed in new trackage, not considering the reconstruction of the California Street Line formerly operated by the United Railroads, nor considering the outer tracks on Market Street which of themselves do not serve any new territory, 27 miles of single track. The United Railroads has brought into service the Army Street Extension from San Bruno Avenue to 3rd Street, a little over 2 miles of single track, so San Francisco is at the present date over 40 miles of single track behind Mr. Arnold's estimated requirements for this time, or if considering the bus routes, about 24 miles behind. The population growth of San Francisco since 1913 has, if anything, exceeded the predictions of Mr. Arnold. The commercial development also has increased beyond his estimates whereas the transportation development is more than 50% behind.

The Sunset District will receive some relief by the completion of the projected line on Taraval Street connecting with the Twin Peaks Tunnel Line, but additional lines will be needed in this district within the next 5 years. A line must be eventually built across Golden Gate Park connecting the Richmond, now called the Park-Presidio District, with the Sunset District. The Supervisors at one time authorized the construction of this connection but were required to withdraw the order as the Park Commission refused to grant a right of way across the Park grounds. Service at the present time is being given by motor buses, but with the development of the Sunset this will not long be adequate. The building of a line on Taraval Street from 33rd Avenue to the Beach is another extension which will be necessary within 5 years. In the near future some extension will be necessary for the Ocean View and the Railroad Homestead Association tracts and additional transportation facilities are needed in the Excelsior Homestead District. Numerous requests for additional service have also been made by the residents of the Pope Tract, the Clarendon Heights District, the Potrero Hills District, the Hunters Point District and for the district in the vicinity of the Art Palace. A number of these requests have merit and should be included in a program of street railway construction for the next five years. It may be broadly stated that it is the opinion of this office that there are needed to be constructed altogether in the next 5 years, 15 miles of single track, of which 12 miles can be cared for by the Municipal Railway system. The remaining 3 miles can only be properly built as extensions to the United Railroads' system, and the only way that this can be done is by the City acquiring the United Railroads or the construction of these necessary extensions by the City and their operation by the United Railroads.



Track Construction, Market St. above 9th. Car used for applying electric bonds



Track Construction, Market St. at Grant Ave., showing temporary platform to give access to U. R. R. cars

CAUSES OF DELAY IN TRANSPORTATION DEVELOPMENT

Privately Owned Roads:

The principal reasons for the non-development of the privately owned systems are the franchise conditions imposed by the State Law and the City Charter. All of the privately owned systems are operated under franchises granted by the City and County of San Francisco.

All franchises granted prior to January 8, 1900, when the present charter went into effect, and this includes practically all of the existing lines in private ownership, were granted according to the general powers contained in the so-called "Consolidation Act and in the manner provided by the general laws of the State of California." Among the conditions imposed by these laws in the granting of railroad franchises by municipalities were the following:

The term of the franchise could not exceed 50 years.

The franchise must require the railroad corporation to pave all that portion of the street lying between the rails and for 2 feet outside thereof and to keep the same constantly in repair, flush with the street and with good crossings.

Two lines of street railway operated under different management by equal payment of cost may use the same track jointly not to exceed 5 consecutive blocks.

The rates of fare for any distance in one direction must not exceed 5c.

The right to grade, sewer, alter or repair the streets, etc., is reserved to the municipality and if required the railroad company must shift its rails so as to avoid obstructions made thereby.

Each street railroad corporation must pay to the Municipal authorities a license fixed by the said authorities not exceeding in San Francisco \$50 per car per annum.

In 1891 the laws were amended to permit the use of electricity as motive power and validating franchises permitting the same. In 1893 an act was passed requiring that U. S. Mail carriers be transported free.

When in January, 1900, the present Charter of the City and County of San Francisco took effect, it super-

ceded the general laws of the State with respect to franchises and all subsequent franchises have been granted in conformance with its provisions. The principal changes affected by the provisions of this Charter are as follows:

The Board of Supervisors shall have the power to permit 2 or more lines of street railways, operating under different managements, to use the same street not exceeding 10 blocks, each paying equal portions of the cost of construction and maintenance,

Franchises granted by the Board of Supervisors shall not be for more than 25 years, instead of the 50 years permitted under the former State Law.

Franchises shall be granted to such corporations as shall, in response to advertisement for bids, offer to pay to the City the highest percentage of the gross annual receipts arising from the operation or enjoyment of the franchise.

The whole of the railway must be continuously operated and at the end of the term of the franchise "the road-track and bed of such railway and all its stationary fixtures upon the public street shall become the property of the City and County."

Failure to comply with any of the conditions shall cause an immediate forfeiture of the franchise, track, and road bed and there shall be no power of the Supervisors to relieve from such forfeiture or from any such conditions.

Franchises shall not be renewable or regranted.

Upon the expiration of a franchise, if it is deemed inexpedient by the Supervisors to use any of the property reverting to it, the property may, after advertising, be leased to the highest bidder in the manner provided for granting franchises. Such lease shall not be made prior to 90 days preceding the expiration of the franchise.

Amendments to the Charter, approved by the Legislature February 17, 1911, have added the following conditions:

All franchises for street railways shall be subject to the right of the City, upon payment therefor of a fair valuation plus the bonus hereinafter mentioned, to purchase and take over the tangible property and plant. Such valuation shall not include any value of the franchise or any earning power of such property. It shall include as part of cost interest on actual investment prior to operation. If purchase be made within 10 years after granting of franchise, a bonus, of not less than 10 per cent nor more than 20 per cent of the actual cost of the road and appurtenances, shall be paid

the grantee. If purchase be made after 10 years, the bonus shall be 10 per cent. The value and bonus to be fixed by a board of five arbitrators, two appointed by the Mayor, two by the railroad and the fifth by the four arbitrators thus named.

Every franchise shall provide that employees shall be paid not less than \$3.00 per day for 8 hours, completed within 10 hours, with overtime at time and a half.

The effect of these charter provisions and amendments has discouraged private enterprise in street railway development. That this is the case can be readily seen when it is understood that the only street railway constructed, since the adoption of the Charter in 1900, has been the so-called Parkside Line, the franchise for which was secured prior to the adoption of the \$3.00 wage amendment.

One other franchise was granted for a line over Stockton Street, North Point and Chestnut Street to the Presidio. This road was not built, consequently the franchise lapsed.

If ever there has been an opportune time for the United Railroads to make additions to their system it was when they were requested to extend their tracks to serve the Panama-Pacific Exposition. At that time Mr. Mulally, assistant to the President of the Company, emphatically stated that "the United Railroads would not build one foot of additional street railroad under present charter conditions.

Extensions to private systems, unless compulsory under public direction by rights contained in the original franchise, will only be made where some inducement is offered in the way of prospective profits either from earnings or from a bonus paid. Take for example the Parkside system: the franchise for which was not taken out by the United Railroads, but by a real estate company who realizing that transportation must be provided in order to make their holdings salable as residence property secured a franchise and constructed track which was of value only when operated as a part of the United Rail-

roads' system. Without some such incentive the Parkside system would not have been built. Likewise when the Ingleside Terraces were opened for residence sites it was necessary for the owners to subsidize the United Railroads to extend the Parkside service to reach their district.

As the older franchises which control the trunk lines over which cars for the outlying extensions must be operated approach the end of their life, the incentive to make extensions in the outlying districts becomes less and less because the probability of securing the return of the investment grows more remote each year.

Thus, while our Municipal Charter has been instrumental in fostering the construction and growth of a Municipal Railway System, it has been seriously defective in that it prevented rapid transit service being given new and outlying districts which were naturally tributary only to privately owned systems and which could not be properly reached by extensions from the municipal system.

For these reasons there is no question in my mind but that the Charter was framed with the thought that the City would at an early date acquire all of the transportation facilities in the City.

Municipal Roads:

There are several causes tending to limit the extension of the Municipal system. The City has a limit of bonded indebtedness of 15% of its assessed valuation. At the present time the City, with projects to which it is committed, has almost exhausted this limit and there are yet other urgent purposes for which bonds must be issued in the near future. This difficulty could be eliminated by an amendment to the Charter which would reduce the limit of bonded indebtedness to 8% for non-earning projects but which would remove all limits to bonds which might be issued for self-sustaining public

utilities. This would put the City in the same position as a private concern desiring to raise money for the construction of such properties. An effort will be made to have such an amendment adopted at the coming election. This must eventually be done and is sound in principle.

Money for the extensions can only be had by bond issue, by provision in the budget and direct taxation for the same and by the use of earnings from the existing system. The construction of street railway extensions from budget appropriations by direct taxation cannot be considered a very popular or desirable method, particularly when the record of the existing Municipal system is examined. From the two outstanding railway bond issues, 1910 and 1913, some five and a half million dollars of money was expended for street railways. These roads have not only paid the interest on the bonds but are now paying off the bonded indebtedness at the rate of \$201,000.00 per year. They have also provided the money for keeping up the property in the best of condition and have furnished all of the money necessary for the construction of 10.16 miles of new track, and beyond this have created surplus funds inclusive of reserves amounting to \$1,227,918.06. Under these conditions why should not the Charter be amended to permit the issuance of bonds secured by the properties already operating and by the proposed new construction.

Since the completion of the work contemplated in the bond issue the only extensions that have been built have been built from earnings. With the natural tendency to a rising wage scale, it is safe to assume that future earnings on a 5-cent fare will be adequate only for wages, maintenance and renewals, bond interest and retirement, and that future extensions will have to be made from further bond issues.

UNIFIED CONTROL OF STREET RAILWAY SYSTEMS DESIRABLE FOR CITY'S PROPER DEVELOPMENT.

That the control and management of the street railway lines or systems in any city should be under one head is almost elemental. It is fundamentally right, first, because it makes possible the most direct service between any two points; second, because it makes possible the greatest economy in operation; third, it permits of the logical extension of the street railway facilities either to serve or shape the City's expansion.

It is difficult to say which of these three reasons is the most important, for they are all extremely powerful arguments for unified control and how important they are is best seen by further analysis of each.

Under the first head of direct service it is meant that a person could always go from any part of the City to a given destination by the most direct route. This would be made possible, where it does not now exist, either by universal transfer exchange or by the rerouting of cars over the joined trackage of the present separate systems. Some concrete examples of the shortening of distances by the universal transfer exchange could be cited as follows: At the present time a person desiring to go from Ingleside Terraces to the Presidio district must, boarding a Municipal Railway car, ride to Van Ness Avenue, transfer to a Van Ness Avenue car and again transfer at Geary Street or Vallejo Street to another car reaching the particular destination. With universal transfer exchange he need only ride to Church and Market Streets, thence via Fillmore Street to the crossing of the proper line, making a saving of 14 blocks in travel or the payment of a double fare. Again, going from Sunnyside to the City Hall or any place along Van Ness Avenue, a transfer at 30th and Church would save just about a mile extra travel, and probably about 15 minutes' time, but each individual could probably see at once how much of a benefit a universal transfer would be to him.

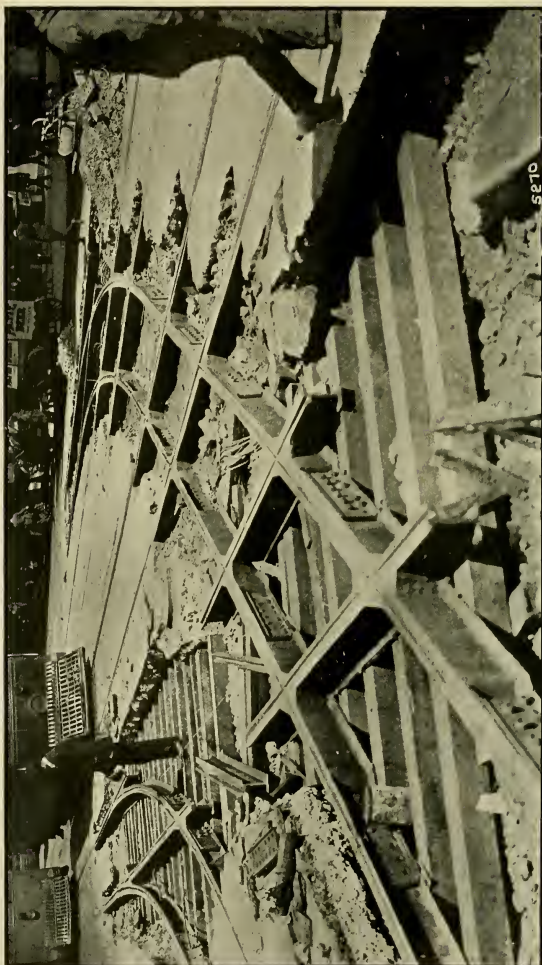
The biggest possibilities, however, for improvement in service would lie in the rerouting of cars over the joint trackage. As a concrete example, practically the same service could be given in the Richmond District by combining the No. 1 cars of the United Railroads and the C cars of the Municipal Line, routing them over California Street to Presidio Avenue and thence down Sutter Street to Market Street. This would eliminate two 600-foot blocks of waste travel for the No. 1 cars and further shorten the run of the C cars. The No. 2 cars of the United Railroads could be continued easterly on Geary Street from 33rd Avenue, thereby saving about 4 blocks waste haul and improving the running time by eliminating all of the curves around the cemetery. The Clement Street cars could be routed over Clement and Second Avenue and down Geary Street or follow the present route which is somewhat longer. Likewise it would be possible to route cars from the Exposition Valley District directly over Van Ness Avenue, 11th to Potrero, 16th and 18th, to the Union Iron Works district, or over Church Street and 16th to the same district. Also it would make possible direct service through the Twin Peaks Tunnel by cars routed over Ocean Avenue, over Sloat Boulevard and over 20th, Taraval and Ulloa Streets. A careful study of the possibilities of rerouting the various cars over joint trackage would reveal numerous other instances,—some probably more important and desirable than those above indicated.

Under the second head of economy in operation, a vast field of possible economies is opened up. In considering that in the preceding paragraph where it is pointed out that time and distance covered would be saved to the street railway patrons by rerouting the cars over more direct lines, we are brought face to face with the fact that useless car mileage would be saved meaning the saving of otherwise wasted money spent in giving this useless service. Every mile that a car travels unnecessarily

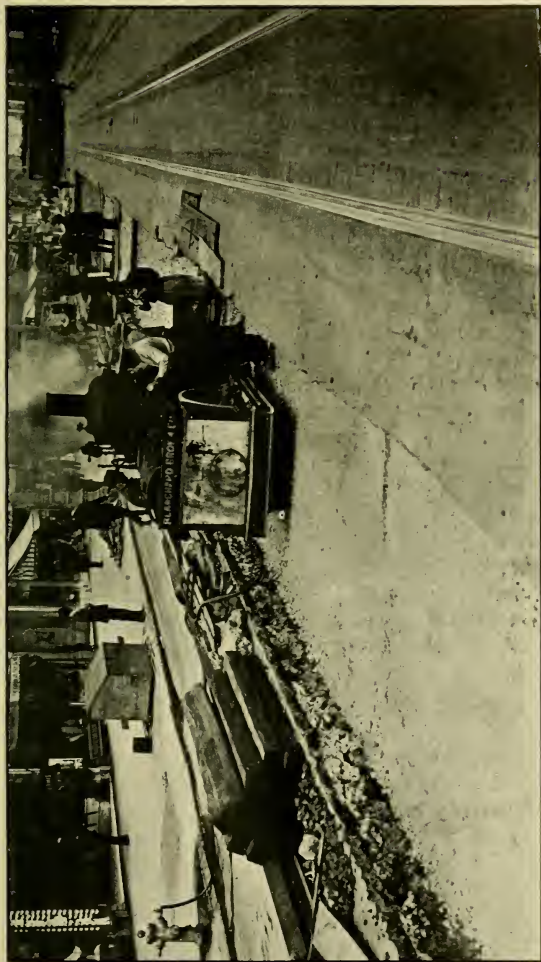
represents the waste of about 25 cents, to say nothing of the value of the time lost by the patrons.

Again, under unified management it would be possible to eliminate a great deal of unnecessary service, particularly where the several systems are operating cars along parallel routes. This is well exemplified in the case of the Richmond District where three car lines,—California Street, Clement Street and Geary Street—run parallel one block—600 feet—apart; while in other portions of the City, such as Park Hill, the lines are 4000 feet apart. Economy could be effected by a reduction in the costs of superintendence, engineering and legal expenses, and again we must emphasize the economy to the traveling public in the time saved by direct service.

The third argument, that of making possible the logical extension of traffic facilities, is of particular importance to the welfare and development of the City. As I have pointed out and emphasized in previous reports, the United Railroads cannot in justice to themselves make any extensions to their system under the existing Charter conditions and their officials have time and again emphatically stated that they would not. As a result there are many districts that are being stunted in their growth by lack of street railway service. The United Railroads, operating 256.6 miles of track to the City's 59.1 miles, naturally would be in a better position to reach into those districts at present without service than the City. For instance, there have been many urgent demands for extensions of service into the Excelsior Homestead District. These people realizing the impossibility of the United Railroads extending into this district have petitioned to have the Municipal Railway extend its Potrero Avenue line to them. Which would mean, roughly, the construction by the City of 4 miles of double track compared with one mile of track should a line be run from the United Railroads' tracks. There have also been numerous requests for an extension of the Municipal Railway into



Installation of Special Work, Geary and Market Sts.



Track Construction, Market above 4th St. Rolling sub-ballast

the Pope Tract. Here again it would be more logical for this service to be given by an extension of the United Railroads than to build a branch of the Municipal system from Geary Street over Masonic Avenue across the Park Panhandle and then practically paralleling existing tracks of the United Railroads. The most striking example, however, is the long talked of extension to serve the Hunters Point District. It could be served by an extension of the United Railroads from Evans and Railroad Avenues far better than by connection with the Municipal Railway system, the nearest point of which would be 25th and Army, one mile further away and which would require two miles more travel for anybody going from the vicinity of 3rd and Market to this district.

The idea of unified management or unified control of the street railway systems is not new. The advantages of this were early appreciated by the street railway operators who effected a consolidation of practically all of the early individual lines, first, under the Market Street system and later under the United Railroads' system. Mr. Arnold in his report made very clear the desirability of evolving some plan by which the street railway facilities would be developed under what he termed a unified system for extensions and he evolved a plan which was submitted to the people as a charter amendment December 10, 1912.

THE ARNOLD PLAN

The plan proposed by Mr. Arnold, after an exhaustive study of street railway conditions in San Francisco, is that generally known and referred to as a resettlement plan under which the existing franchises of the various independent lines making up the United Railroads' system would be abandoned in exchange for certain privileges to be granted under resettlement franchises. To effect the plan several changes in the Charter were necessary. These were all embodied in what was known

as Charter Amendment No. 34, adopted by the Board of Supervisors November 7, 1912, and voted on December 10, 1912. The most important provisions of this proposed Charter amendment are as follows:

No franchise for a public utility shall be granted unless containing provision that extensions shall be made as the public need requires; likewise that the City may purchase the franchises and property at the public option. The Board of Supervisors would have the power to grant franchises, subject to referendum. Among other conditions we find that if at the end of 25 years the investment has not been amortized, and the City has not exercised its option to purchase, an extension of the franchise not to exceed 15 years may be granted,—the City reserving the right to terminate the franchise sooner by purchase or by finding a purchaser under fair terms. This amendment also provided that the Board of Supervisors might negotiate resettlement franchises upon certain terms and conditions among which were, resettlement franchises must provide for the City's right to purchase franchise and the physical properties involved upon six months' notice; and the grantee must make extensions to meet the City's needs. No resettlement franchise shall be for more than 20 years unless the intangible values are amortized in 20 years and the price reduced accordingly, nor shall the life of a resettlement franchise exceed 40 years without the value of the physical property being amortized and the price reduced accordingly. Each resettlement franchise must name a price which shall be the basis for future purchase by the City. The actual purchase price shall be determined by adding or deducting from the base price accordingly as the capital account has been increased or decreased due to betterments or the withdrawal of property; from this figure shall be subtracted depreciation together with the amount of the amortization.

It further provided that the City might designate a licensee to take over the franchise and property under the

same terms and conditions that the City itself might do so; and further, in each resettlement franchise, made such a resettlement applicable to any adjoining territory outside of San Francisco whenever the same might be annexed to San Francisco.

The purpose and principles of the Arnold plan were quite desirable and there is no doubt but what if this plan had been adopted San Francisco's development would have been much enhanced, and many new districts now without service would have been provided with transportation. This Charter amendment, however, was defeated and interest in the acquisition of the United Railroads waned to be revived at various intervals.

PURCHASE OF THE UNITED RAILROADS

On June 8, 1914, Supervisor Alex. Vogelsang introduced a resolution in the Board of Supervisors authorizing the Public Utilities Committee to examine and investigate the legal and financial questions involved in the acquisition of the United Railroads; to examine, investigate and value the physical properties and franchises of said United Railroads; to request of the United Railroads the prices and terms upon which it would sell and transfer its railroad properties to the City and County of San Francisco; authorizing said Public Utilities Committee to employ the services of the Board of Public Works, the Engineering Department and the City Attorney's office as far as might be necessary; and, to report thereon to the Board of Supervisors. Nothing, however, came of this and the interest again flagged.

In my Report for the year 1915-16 I stated: "The more carefully the situation is studied the more urgent appears the necessity for the unification of the control of all existing railroad lines and until this has been accomplished San Francisco will have to put up with a more or less inadequate transportation system."

Interest in the acquisition of the United Railroads' system by the City was again revived in September, 1917, when Mr. Gavin McNab came forward and suggested a method by which it might be possible to purchase the United Railroads' system out of its earnings.

The McNab Plan:

The plan suggested by Mr. McNab, which seemed to offer a basis for the City and the United Railroads getting together, is briefly that the value of the physical properties of the United Railroads should be determined and the United Railroads should be paid this amount plus the estimated net earnings for the unexpired franchise periods. The Board of Supervisors on September 27, 1917, adopted Resolution No. 14,852, as follows:

"Resolved, That it is for the best interests of the people of the City and County of San Francisco that the City and County acquire all of the properties of the United Railroads if said properties can be purchased upon equitable terms.

Resolved, further, That the City Engineer be and is hereby authorized to confer at once with a representative of the United Railroads for the purpose of arriving at a basis of valuation and that he report at an early date to this Board."

Negotiations for Purchase of United Railroads and the basis of Valuation agreed upon:

Following the resolution of the Board of Supervisors, the matter was taken up immediately with Mr. Lilienthal of the United Railroads, who designated Mr. Wm. von Phul, the Vice-President and General Manager of the United Railroads, as the representative of the United Railroads to discuss and agree with the City Engineer on a basis of valuation. Between October 2, 1917, and March 4, 1918, numerous conferences were held between the City Engineer and Mr. von Phul. These conferences resulted in this office transmitting to the Board of Supervisors a report setting forth a basis of valuation which had been agreed upon with the United Railroads. This report is as follows:

"March 4, 1918.

To the Honorable The Board of Supervisors of the
City and County of San Francisco.

Gentlemen: Under date of September 27, 1917 your Board adopted Resolution No. 14852, as follows:

"Resolved, That it is for the best interests of the people of the City and County of San Francisco that the City and County acquire all of the properties of the United Railroads if said properties can be purchased upon equitable terms.

Resolved, further, That the City Engineer be and is hereby authorized to confer at once with a representative of the United Railroads for the purpose of arriving at a basis of valuation and that he report at an early date to this Board."

Acting under this resolution, on the same day I addressed a letter to Mr. Lilienthal, President of the United Railroads, in order to arrange a meeting with a representative of that Company to discuss the matter. The United Railroads delegated Mr. William von Phul, Vice-President and General Manager, as their representative to confer with me, in an endeavor to arrive at a basis of valuation for the properties.

Subsequently numerous meetings were held between Mr. von Phul and myself, with the result that on Saturday, March 2nd, the following memorandum of a basis of valuation for the purchase and sale of the United Railroads properties was agreed on by Mr. William von Phul, Vice-President and General Manager of the United Railroads, representing that Company, and myself representing the City and County of San Francisco:

"1. The sale price of the properties of the United Railroads of San Francisco to the City and County of San Francisco shall be the agreed present physical value of the property plus an amount equivalent to the probable net earnings of the railroad properties during their remaining franchise life.

"2. The present physical value shall be the cost to reproduce new as of December 31, 1917, with allowance for betterments to date of consummation of sale, less depreciation, based on the actual physical condition at the date of the consummation of sale. The cost to reproduce new shall be based on a physical inventory of the property and unit prices representing the average of normal conditions for the five year period 1913-1917 inclusive, and cognizance shall be taken of existing conditions at the time the present property was constructed. The general principles recognized by the Interstate Commerce Commission and the State Railroad Commission shall be followed in making the valuation. In the valua-

tion of the physical property, abandoned trackage shall be taken at its value for old material, and allowance made for its removal and the restoration of the streets.

"3. The probable net earnings—to be computed by the best agreed methods—of the properties during the remaining franchise life shall be the difference between the probable gross revenue and the probable gross operating expense for the properties for the period from the date of consummation of sale up to and including the year in which franchises, approximating 134 miles, have expired, plus an allowance for the additional net earnings of the remaining several and isolated lines if operated independently to the expiration of the several franchises. The net earnings shall be taken as the remainder of the gross receipts of the property after deducting operating expenses, taxes, depreciation sufficient to maintain the properties in their present condition under like future operating conditions, and interest on the agreed value of the physical property at the same rate which the City shall pay upon its deferred payments for the physical property.

"4. Payments on the purchase price of property shall be made semi-annually from the operating receipts. Deferred payments on the physical value of the property shall bear interest at $4\frac{1}{2}$ per cent per annum. Payments on that portion of the net earning value of the property shall bear no interest.

"5. Nothing in the above basis of valuation shall be construed to prevent the establishment of a fair price for the purchase and sale of the properties as between a willing seller and a willing buyer.

"6. In the event that the representatives of the United Railroads and of the City are unable to reach an agreement, then such matters as are in dispute shall be referred to an arbitrator who shall be jointly selected by the City Engineer and the representative of the United Railroads. Any expenses incurred in arbitration shall be borne equally by the United Railroads and the City of San Francisco."

Should your Board desire to continue further in this matter, in accordance with the expressed intention of the Resolution, it will be necessary to proceed and make a complete valuation of the United Railroads properties in order that the price may be determined upon and finally submitted to the people.

If it is the intention of your Board to have this matter submitted to the people this year, it is imperative that no time be lost in proceedings with the work of valuation.

Respectfully,

M. M. O'SHAUGHNESSY, City Engineer.

This basis as finally agreed upon is felt to be fair both to the City and to the United Railroads. The matter was approached with open mind and an earnest endeavor to reach an equitable agreement. The principle which guided this office in arriving at the tentative agreement was that the City was willing to pay the United Railroads for its properties such a sum of money and in such payments as would be equivalent to the probable net amount which the United Railroads might realize by the operation of the properties to the ends of their several franchises; and the final disposal of the properties on the basis of their physical value. In other words, the United Railroads was entitled to secure under the terms of the McNab purchase, exactly what they would get if they continued to operate the roads themselves under the present and future conditions. The advantage which the City would derive under these conditions would be such advantages as would result from economies which might be effected under unified management, such as, reduction of overhead operating expenses, the saving by the rerouting of cars and the economies of making extensions from logical trunk lines. Also there would be a very material benefit to the City as a whole from the improved property values in outlying districts and the elimination of any unrest due to the antagonism toward the United Railroads.

Following the submission of the report of the City Engineer the Board of Supervisors on March 25, 1918, adopted Ordinance No. 4538 (N. S.) by vote of 16 to 2, Supervisors McSheehy and Schmitz voting against it. This ordinance declared that public interest demanded the acquisition of the United Railroads' system and authorized and directed the Board of Public Works to make a valuation for the purpose of arriving at a purchase price for the properties in accordance with the terms stated in the report of the City Engineer, and appropriating for the valuation work the sum of \$15,000. On August 5, 1918,

J. M. Mobley, the Secretary of the Carmens' Union, secured a temporary injunction from the Superior Court restraining this office and the Board of Public Works from spending any money from the Municipal Railway Fund for the purpose of making a valuation of the United Railroads, thus stopping for the time being any action by this office looking towards the acquisition of the United Railroads properties.

The necessity of the City's acquiring the United Railroads' property and the unification of the railway systems of San Francisco is extremely urgent. This is appreciated by many of the best thinkers in the City, even by those who are opposed on general principles to expressed themselves and endorsed the plan of the City acquiring the United Railroads' property are Edward Robeson Taylor, former Mayor of San Francisco; Marshall Hale, Director of the Pacific Division of the American Red Cross; Phil Teller, President of the Commercial Club; A. S. Baldwin, of Baldwin & Howell; I. W. Hellman, Jr., Union Trust Company; A. J. Pillsbury, State Accident Commission; John O'Connell, Secretary of San Francisco Labor Council; Frank McDonald, Vice-President of the State Building Trades Council, and R. E. Miller, President of the Owl Drug Co. The movement to acquire the United Railroads, although temporarily thwarted by a few misguided citizens, must go on. As the expiration of the early franchises of the United Railroads approaches, the necessity of the City taking over the lines will become more urgent and more apparent. It may be possible that the City's Charter specifying a method for acquiring ownership of public utilities will have to be amended. This Charter was framed nearly 20 years ago, before the City had any experience with ownership of public utilities, and the means furnished by the Charter for the acquisition of utilities are inadequate to meet the conditions of today. As already pointed out, under the Charter, the City may

issue bonds only to the extent of 15% of the assessed valuation in the City. This includes all bonds for whatsoever purpose issued, whether for public utilities which are self-sustaining, such as railroads, or for sewers, which are not self-sustaining. It does not seem proper that bonds for the acquisition of public utilities, which are going concerns and capable of not only paying the operating expenses but amortizing the invested capital, should be included in the limit of bonded indebtedness that may be incurred by the City. As long as this condition exists it will probably be impossible for the City to issue bonds to cover the entire purchase price of the United Railroads system; although if bonds were issued to buy the property at a fair price there is no question but what the interest on them could be paid out of the earnings of the system and a sinking fund created which would free the entire property of encumbrance within 25 or 30 years, and at the same time make reasonable extensions to the system.

New York City has advanced about \$200,000,000 to transit systems to secure a uniform low fare over a very extended area, and is now compelled to change the fare rate of 5 cents. Boston, which advanced \$40,000,000 has been compelled to climb to an 8 cent and may go to a 10 cent fare, so that successful solution of transit problems in large cities is a burden the communities will have to assume—or suffer from inadequate service.

NEW RAILROAD WORK CONSTRUCTED DURING THE FISCAL YEAR 1917-18

During the past fiscal year there has been completed and placed in operation 15.20 miles of street railway trackage. This work was done under the following contracts:

Contract No. 23A:

Church Street Line from Market Street and Van Ness Avenue to 16th and Church Streets. This contract

was awarded to the Western Motor Drayage Company on March 16, 1917. It covered the construction of the equivalent of 9965 feet of single track constructed as outer tracks on Market Street and on Church Street to 16th. It included the installation of nine pieces of track special work and all of the pavement incidental to the track construction. This contract was completed August 28, 1917, with the exception of a few minor details and the road was placed in operation on August 11, 1917. The contractor earned by the early completion of the work 16 days' bonus at \$100 per day. The total amount of the contract was \$83,138.54. This contract was a part of the work contemplated under the 1913 bond issue and formed the last link in the completion of the Church Street Line, Sections B and C having been completed in the preceding year.

Contract No. 95:

Twin Peaks Tunnel Line from Castro and Market Streets to Junipero Serra Boulevard. This contract was awarded to Eaton & Smith June 22, 1917. It included the construction of approximately 15,000 feet of double track construction which, with the exception of a few street crossings at the westerly end of the line, was of 70 pound T-rail construction, 12,000 feet of the work was within the Twin Peaks Tunnel. This contract included the installation of the overhead electrical work and the construction of curbing around the right of way west of the tunnel. The overhead trolley construction through the tunnel is of the catenary form and west of the tunnel, along West Portal Avenue, standard center pole construction is used. Work on this line was commenced on July 14th simultaneously with the completion of the Twin Peaks Tunnel. The work was very efficiently handled by the contractors, who first hauled into the tunnel the rail and track material for the construction of one track, at the same time installing the overhead trolley through the tunnel. The

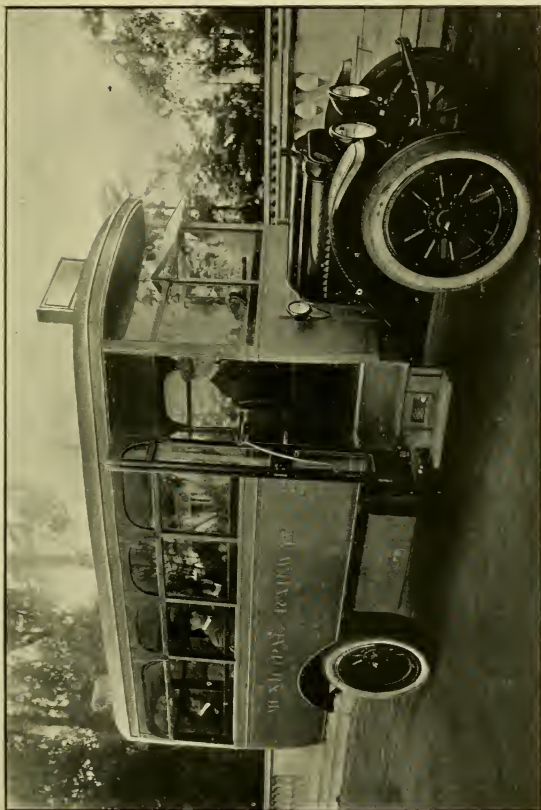
standard work car of the Municipal Railway was then employed to haul the material for the other track and all of the ballast and other materials necessary to complete the work. The line was practically completed, with the exception of a few minor details, on January 16, 1918. It was not possible to place the line in operation, however, until February 3, 1918, as war conditions prevented the delivery from the East of the special crossings for the United Railroads tracks at 17th and Castro, prior to that time. The cost of the work under this contract, including 24 days' bonus at \$50 per day for the early completion of the work, was \$79,291.65.

Contract No. 96:

Market Street Line from Church to Castro Street. This contract was awarded on August 31, 1917, to James M. Smith for the firm of Eaton & Smith. This contract covered the construction of the equivalent of 5,278 lineal feet of standard single track with pavement laid as outer tracks and the installation of two pieces of track special work. It was completed December 12, 1917, with the exception of a few minor details but was not placed in operation until February 3, 1918, when operation through the Twin Peaks Tunnel was commenced, the operation of this line being likewise held up by the non-delivery of the special crossings as noted above. The contractor earned under this contract the sum of \$37,805.94, which includes a bonus of \$1500.00.

Contract No. 97:

Market Street Line from Geary Street to Van Ness Avenue. This contract was awarded on February 6, 1918, to the Western Contracting Company. The work was completed with the exception of some force account work and some items of minor importance on June 1, 1918. This contract was by far the most important piece of street railway construction carried out during the last fiscal year. The amount of money involved was not as



Municipal Railway Auto Buses

much as in some of the previous contracts but due to the location of the work on Market Street from Van Ness Avenue to Third Street, right along the City's main traffic artery and in the part of the shopping and business district, the period of construction was looked forward to with some considerable degree of apprehension by the storekeepers, merchants and business men along the route. The difficulties of the work were enhanced by the fact that the tracks were to be constructed along parallel and outside of the existing United Railroads' tracks on that street and that during the construction it was necessary to care for all of the team and vehicular traffic and also street railway traffic of the United Railroads. Some detail as to how this work was handled has been noted elsewhere in this report.

This contract was completed June 1, 1918, on which day regular traffic over the line was inaugurated. The cost of the work covered by the contract, as conditionally accepted July 1, 1918, and including a bonus of \$7000.00, was \$137,194.55.

Contract No. 98:

For the construction of the Taraval Street Line of the Municipal Railway from West Portal Avenue via Ulloa Street, 15th Avenue and Taraval Street to 20th Avenue. Bids on this contract will be received on the 17th day of July, 1918. This contract calls for the construction of about 3750 feet of standard double track connecting with the Twin Peaks Tunnel Line at the West Portal of the tunnel and the Tracks of the United Railroads on Taraval Street at 20th Avenue. This Company's tracks will be utilized from 20th Avenue westward under a proposed agreement yet to be made. The estimated cost of the work to be done under contract is \$40,000.

Contract No. 99:

For installing electric conductors and appurtenances, Market Street Line, from the east portal of the Twin

Peaks Tunnel to Church Street, and from Van Ness Avenue to Geary Street. This contract was awarded to H. S. Tittle Company, October 26, 1917. It covered the installation of approximately 9400 double track feet of 3/0 trolley wire and fittings attached to the United Railroads' suspension spans. Also the installation of approximately 1500 lineal feet of 250,000 circular mill paper insulated, lead covered feeder cable, installed in ducts which had been constructed under Contract No. 96. The work of this contract was completed early in January, 1918, but the final acceptance was not made until the line had been placed in operation and the final tests made by the actual operation of cars over the completed track work. The contractor earned on the contract \$4328.34, including \$600.00 bonus for early completion of the work.

Contract No. 100:

For furnishing and delivering steel rails, rail joints and fastenings. This contract was divided into four sections.

Section A, covering the delivery of approximately 520 tons of rail and rail joints, was awarded to United States Steel Products Company.

Section B, covering the delivery of some 15,000 tie plates was awarded to Eccles & Smith Co.

Section C, covering the delivery of 2,000 tie rods, was awarded to Payne's Bolt Works.

Section D, covering the delivery of 80 kegs of spikes, was awarded to the United States Steel Products Company.

These contracts were all awarded December 14, 1917. Section A and D were completed by the Steel Products Company and acceptance made on July 5, 1918, the amount paid the contractor being on Section A, \$41793.30, and on Section D, \$875.20.

Section B was completed and accepted February 11, 1918, and the contractor paid the sum of \$5250.00.

Section C was accepted June 14, 1918, and the contractor paid the sum of \$1238.76.

This material covered primarily the rail required for the construction of the Taraval Street Line and the replacement of stock rail used on the Market Street Line.

Contract No. 101:

For furnishing and delivering wood ties. This contract was awarded to J. H. Baxter & Co., December 14, 1917, and covered the delivery of 6000 redwood ties, primarily for use in the Taraval Street Line. Under this contract there were delivered 5834 ties at 93 cents each, making a total of \$5425.62. The acceptance of this work was recommended March 13, 1918.

Contract No. 102:

For the construction of the "D" Line Extension, Municipal Railway System, on Greenwich Street between Scott and Baker Streets. This contract was awarded to Eaton & Smith on February 25, 1918, and covered the construction of 3 blocks of track on Greenwich Street from Scott to Baker, with the incidental pavement and the removal of two blocks of track on Scott Street between Chestnut and Greenwich Streets, together with the installation of a standard turnout at Baker and Greenwich Streets connecting the new line with the Union Street Line.

This work was completed with the exception of a few minor details on May 4, 1918, at which time operation of cars over it was commenced. The total amount of money earned by the contractor was \$30,932.94, including a bonus of \$750.00. This piece of line permits operating the cars of the "D" Line to the Presidio as a terminus instead of the previous terminus at Scott and Chestnut Streets. By doing this a great deal of the burden on the

small cars of the "E" Line (Union Street) was relieved as this connects the western end of the Union Street Line with the shopping and theatre district by a more easily operated and direct route.

Contract No. 103:

For furnishing and delivering railway signal material, Twin Peaks Tunnel Line, Municipal Railway System. Specifications were prepared and bids were opened on March 27, 1918. The lowest bidder was the Federal Signal Company in the sum of \$7200.00 f. o. b. Albany, N. Y. All bids were rejected because the installation of a block signal system in the Tunnel will not be an essential until the headway of cars is greatly reduced; when it is likely that a much more advantageous bid can be secured.

The track bonding, which was performed under Contract No. 95, was installed in such manner as to take care of the installation of signals any time without increased expense.

Contract No. 104:

For furnishing and mounting automobile bus bodies, Municipal Railway System. Specifications are being prepared and bids will be invited in August, 1918, for equipping 5 White Company's 2-ton chassis, recently purchased, with bus bodies of a type similar to those originally purchased for the Municipal Railway System under Contract No. 88.

Contract No. 105:

For furnishing and delivering copper trolley wire, Municipal Railway System. Specifications have been prepared and bids will be received July 18, 1918, for furnishing approximately 21,500 pounds of round 3/0 hard drawn, copper trolley wire, which is to be used primarily for the Taraval Street Line and to replace stock used over some of the recent extensions.

Contract No. 106:

For furnishing and installing reinforced concrete trolley poles for the Taraval Street Line from West Portal Avenue, via Ulloa Street, 15th Avenue and Taraval Street, to 20th Avenue. Specifications have been prepared and bids invited to be opened July 19, 1918, for this work, which includes furnishing and installing 64 standard concrete concrete poles and 12 strain poles for the Taraval Street Line, Contract No. 98.

Contract No. 107:

For installing electric conductors and appurtenances, Taraval Street Line from West Portal Avenue via Ulloa Street, 15th Avenue and Taraval Street, to 20th Avenue. Specifications are being prepared and bids will be invited for the installation of the trolley work for this line, so that the work can commence immediately upon the erection of the poles.

Contract 23-E:

For installing electric conductors, Church Street Line, from Market Street and Van Ness Avenue to 16th and Church Streets. This contract was awarded to H. S. Tittle, May 18, 1917, and covered the installation of 5500 double track feet of 3/0 trolley wire with necessary feeders and equalizer spans; 1100 lineal feet of 250,000 circular mill, and 8700 lineal feet of 500,000 circular mill, paper insulated, lead covered feeder cable, installed in underground conduits constructed under Contract No. 23-A. The contract was completed and accepted, August 23, 1917. The contractor earned \$6925.00, including a bonus of \$300.00 for the early completion of the work.

RAILWAY WORK OTHER THAN CONTRACT

During the last fiscal year activities of the office in connection with railway work other than those spoken

of hereinbefore cover a very broad field. One of the most important problems having been the readjustment of the tracks at the foot of Market Street to relieve congestion of street railway traffic during the morning and evening hours. This work was carried out as an extra on Contract No. 23-A and involved the relocation of tracks at the throat of the loop at the Ferries and the installation of a cross-over from the inner to outer east-bound track at Spear Street. This work was done to secure satisfactory operation of the increased number of cars at the Ferry following the completion of the construction of the outer tracks on Market Street. The placing of these additional cars on Market Street during the rush hours presented an extremely difficult problem, especially when it is realized that in 1913 Mr. Arnold in his report stated (pp. 296), "From a careful study of existing conditions and the reasonable requirements of increasing traffic, I fail to find any satisfactory solution of the Ferry terminal problem that can be carried out on the surface within the existing street lines." And again (pp. 305), "An unusual opportunity presenting itself during the recent Belt Railroad construction to observe the adequacy of the present loop laid out for Ferry traffic. During this time the inner loop only was in operation for and accommodating all Market Street Lines. By actual count 134 cars per hour passed around this one loop, but the congestion resulted in the stalling of one complete line of cars as far back as 2nd Street, over 3,000 feet. * * * * Obviously therefore, the maximum capacity of the inner loop represented 80 cars per hour if it is desired to avoid congestion along lower Market Street and to enable commuters to reach their boats promptly. * * * * The total capacity of the two loops, assuming unobstructed entrance to the terminal, probably does not exceed 160 cars per hour."

In April of this year, two months before the City commenced the operation of the J and K cars to the Ferry,

in the evening rush hour the City was operating 61 cars per hour, and the United Railroads 81 cars per hour around the outer loop, a total of 142 cars, and on the inner loop the United Railroads was operating 102 cars. These 244 cars were being handled under the same conditions as Bion J. Arnold stated would not permit of passing more than 160 cars per hour as a maximum. The conditions in April, 1918, were not considered unsatisfactory and there was no general complaint from the patrons. It is probable, however, that the number of cars being operated at that time, 244, marked about the limit of satisfactory operation under the conditions at that time, and was 50% more than Arnold's limit.

With the completion of the outer tracks on Market Street, approximately 40 additional cars per hour would have to pass the outer loop, which under the conditions was a physical impossibility. To overcome this difficulty the City Engineer, in a letter to the Board of Public Works dated May 3, 1918, recommended that the tracks at the throat of the loop be spread and a cross-over be installed at Spear Street. The object of this was to increase the clearance and permit two cars, one on the inner and one on outer track, to enter the loops abreast, instead of passing one at a time over the throat of the loops. The cross-over at Spear Street permits cars, which previously switched from the inner to the outer tracks after entering the loop, to make this change while waiting for vehicular traffic to cross the loop and to enter the loop on the proper track. Without the cross-over at Spear Street the spreading of the tracks at the throat of the loop would have been only partially effective, and vice versa. When these changes were made the conditions improved to such an extent that during normal rush hours the 284 cars of the United Railroads and Municipal Railways operated more satisfactorily than they had prior to the putting on of the additional cars with the old

arrangement of tracks. However, the cars would pile up on lower Market Street for several blocks at any little delay at the Embarcadero caused by more than usual heavy vehicular traffic crossing the loop, or by the increased period of loading at the time of boat landings. This congestion, which occurred during about 15 minutes in the morning and a half hour in the evening, caused considerable comment from various sources and an appeal was made to the State Board of Harbor Commissioners for some action, with the result that the Harbor Board requested that the United Railroads and the City secure the necessary relief. After a study of conditions a plan for the relief of congestion was developed calling for: First, the construction of a subway to pass vehicular traffic under the tracks of the loop, with the recommendation that one-third of the expense of this subway be borne by the Harbor Commission and one-third each by the City and the United Railroads. This subway is to be 1100 feet long and 20 feet wide, costing about \$250,000.00. Second, a relocation of the present outer loop and the construction of a third and outer loop, the City and the United Railroads each to have a full one-half interest in both the middle and outside loops. The Harbor Commission agreed to the construction of the third loop but deferred action on the subway until the third loop had been completed and the measure of its relief determined. The third loop will improve conditions largely through providing increased berthing capacity at the Ferry, it being possible to accommodate six more cars on the loops at one time than was possible with the two old loops. This will practically double the time which can be used in loading the cars, being of particular importance at the time of the arrival and departure of boats.

In the foregoing analysis of the Lower Market Street problem only physical and operating matters have been touched upon. It must, however, be borne in mind that at the present time the "C" and "D" cars of the Municipal

Railway are operating to the Ferry only upon consent from the United Railroads, who furnish the necessary power at $11\frac{1}{4}$ c K. W. H. This consent of the United Railroads was given following an injunction issued by Judge Seawell restraining the City from using the wires, poles and current of the United Railroads on Market Street from Sansome to the Embarcadero. The "J" and "K" cars of the Municipal Railway are in the same category as the "C" and "D" below Sansome Street, and it would be possible for the United Railroads at any time to have a similar injunction issued preventing the use of trolley and power by "J" and "K" cars. Further, the City's trolley wires over the outer tracks from 17th Street to Sansome Street are suspended from the poles and spans of the United Railroads. Any encroachment by the City upon what the United Railroads believe to be their rights on either lower Market Street or at the Ferries would bring forth every possible legal effort to prevent the City operating not only the "C" and "D" cars east of Sansome Street, but also the "J" and "K" cars over the entire length of the four tracks. This might compel the City to install a separate set of poles and span wires along the entire length of Market Street. These, besides injuring the appearance of Market Street, would probably entail an expenditure of close on to \$75,000, and would not improve the present operating conditions.

STATISTICAL

In order to complete the statistical portion of this report, I am appending hereto six tables, as follows:

- I. Contract Expenditures out of the 1913 Municipal Railway Bond Issue up to July 1, 1918.
- II. Contract expenditures out of Municipal Railway Earnings up to July 1, 1918.
- III. Other than Contract Expenditures made out of 1913 Bond Issue.

MUNICIPAL RAILWAY SYSTEM—BOND ISSUE AUTHORIZED AUGUST 26, 1913

of Work	Date Was	Contract Awarded	Contractor	Contract Price	Date Contract Was Signed	Time Allowed Days	Extensions Granted Days	Estimated Value of Work completed July 1, 1917	Estimated Value of Work completed July 1, 1918	Estimated Value of Work completed July 1, 1919	Per Cent Completed	
Steel Rails, Rail Joints & Fastenings	Jan. 16, 1914		H. S. Steel Products Co.	\$145,514.22	Jan. 26, 1914	125		\$ 149,175.28	\$ 113,175.28		100	
Steel Rails & Nuts	Jan. 2, 1914		Payne's Bolt Works	8,514.50	Jan. 9, 1914	120		3,511.15	3,511.15		100	
Steel Plates & Rail Braces	Jan. 2, 1914		Eccles & Smith Co.	15,264.32	Jan. 15, 1914	120		15,264.32	15,264.32		100	
Steel Spikes	Jan. 2, 1914		U. S. Steel Products Co.	2,550.00	Jan. 13, 1914	100		2,550.00	2,550.00		100	
Wood Cross Ties	Jan. 2, 1914		Chapman Lumber Co.	37,990.00	Jan. 14, 1914	180		33,139.00	33,139.00		100	
Super Rail Bonds	Mar. 20, 1914		Bell & Jamison	35,186.00	Apr. 2, 1914	12/20/14	Until notice	22,448.75	22,448.75		100	
Special Work	Jan. 2, 1914		U. S. Steel Products Co.	87,788.00	Jan. 13, 1914	210		108,576.00	108,576.00		100	
Special Work	Apr. 17, 1914		U. S. Steel Products Co.	27,500.00	May 13, 1914	110		26,747.00	26,747.00		100	
Track Special Work	Oct. 23, 1914		U. S. Steel Products Co.	6,161.00	Nov. 6, 1914	80		6,611.00	6,611.00		100	
Track Special Work Church St. Ry.	July 28, 1915		U. S. Steel Products Co.	2,302.00	Dec. 15, 1915	100		4,264.00	4,264.00		100	
Concrete Trolley Poles	Apr. 17, 1914		H. S. Tittle	35,599.67	May 1, 1914	180		40,966.25	40,966.25		100	
Operating Devices on requisition	June 15, 1914		Harbour Stockwell Co.	490.00	June 20, 1914			490.00	490.00		100	
Underground Conduit Material	Mar. 16, 1914		H. W. Johnson-Manville Co.	9,254.40	Apr. 6, 1914	100		9,252.93	9,252.93		100	
Underground Conduit	Apr. 17, 1914		Stand. Underground Cable Co.	31,126.57	July 8, 1914	75		31,195.19	31,195.19		100	
Castings	Apr. 17, 1914		Enterprise Foundry Co.	2,355.00	Apr. 30, 1914	75		2,398.42	2,398.42		100	
Steel Car Bodies	Jan. 2, 1914		Jewett Car Company	*280,000.00	Jan. 16, 1914	300		265,816.50	265,816.50		100	
Street Car Trucks	Jan. 2, 1914		Baldwin Locomotive Works	*58,000.00	Jan. 16, 1914	270		74,165.00	74,165.00		100	
Street Car Motor Equipments	Jan. 2, 1914		Westinghouse Elect. Mfg. Co.	*217,600.00	Jan. 26, 1914	285		290,750.00	290,750.00		100	
Street Car Air Brake Equipments	Jan. 2, 1914		Westinghouse Trac. Brake Co.	*21,000.00	Jan. 19, 1914	220		23,125.00	23,125.00		100	
Underground Electrical Conductors, Union St. Ry.	Mar. 6, 1914		Bay Cities Engineering Co.	4,700.00	Mar. 19, 1914	60		4,700.00	4,700.00		100	
Underground Electrical Conductors	Mar. 6, 1914		Pacific Cns. & Electric Co.	5,785.73	Mar. 25, 1914	60		5,785.73	5,785.73		100	
Underground Lines, Track, Poles & Conduit	Mar. 20, 1914		Mahoney Bros.	219,747.50	Apr. 4, 1914	150		235,277.53	235,277.53		100	
Underground Trolley Poles, Van Ness Line	Mar. 16, 1914		H. S. Tittle	33,256.26	Mar. 30, 1914	120		35,730.90	35,730.90		100	
Machine Shop Equipment:												
Machine	Apr. 24, 1914		Harron, Rickard & McCone	3,165.00	May 8, 1914	60		2,965.00	2,965.00		100	
Machine	Apr. 24, 1914		Berger & Carter Co.	1,393.00	May 11, 1914	60		1,337.09	1,337.09		100	
Machine	Apr. 24, 1914		Eccles & Smith Co.	240.00	May 12, 1914	60		240.00	240.00		100	
Machine	Apr. 8, 1914		J. O'Shea	1,211.15	Apr. 27, 1914			1,242.65	1,242.65		100	
Machine	May 8, 1914		C. B. Eaton & Jas. Smith	131,767.80	May 23, 1914	120		162,316.64	162,316.64		100	
Machine	May 14, 1914		F. Rolandi	125,773.10	June 20, 1914	150		143,795.16	143,795.16		100	
Machine	Dec. 14, 1914		F. Rolandi	101,308.81	Dec. 29, 1914	105		114,945.03	114,945.03		100	
Machine	Dec. 16, 1917		Western Motor Draying Co.	74,431.30	Mar. 30, 1917	110		83,133.55	83,133.55		100	
Machine	Dec. 10, 1915		Contra Costa Construction Co.	120,500.00	Dec. 27, 1915	150		127,345.33	127,345.33		100	
Machine	Jan. 19, 1916		Western Motor Draying Co.	57,455.93	Feb. 8, 1916	105		56,734.19	56,734.19		100	
Machine	Apr. 16, 1917		John Sparzo	15,706.00	Apr. 30, 1917	75		5,162.04	7,177.83		100	
Machine	May 18, 1917		H. S. Tittle	7,176.00	May 31, 1917			6,925.00	6,925.00		100	
Machine	June 26, 1914		Pacific Fire Extinguisher Co.	23,947.95	July 11, 1914	1/1/15		27,302.81	27,302.81		100	
Machine	June 12, 1914		H. S. Tittle	36,245.85	June 27, 1914	1/1/15		41,111.22	41,111.22		100	
Machine	Aug. 28, 1914		C. B. Eaton & Jas. Smith	9,775.00	Sept. 12, 1914	30		11,091.95	11,091.95		100	
Machine	July 13, 1914		The Daniel O'Day Co.	34,850.00	July 23, 1914	90		35,965.00	35,965.00		100	
Machine	Dec. 4, 1914		Clinton Fireproofing Co.	196,900.00	Dec. 13, 1914	160		216,082.28	216,082.28		100	
Machine	Nov. 30, 1914		Pennsylvania Steel Co.	9,146.97	Dec. 15, 1914	40		6,270.37	6,270.37		100	
Machine	Informal		Various	1,853.26				1,853.26	1,853.26		100	
Machine	May 12, 1915		Ralston Iron Works	2,820.00	May 27, 1915	45		2,820.00	2,820.00		100	
Machine	May 12, 1915		Butte Eng. & Electric Co.	1,656.00	June 5, 1915	90		1,656.00	1,656.00		100	
Machine	July 12, 1915		F. Rolandi	8,400.00	July 12, 1915	60		8,738.54	8,738.54		100	
Machine	July 30, 1915		Pacific Car & Equipment Co.	3,250.00	Aug. 14, 1915	120		3,086.14	3,086.14		100	
Machine	July 30, 1915		Westinghouse Elec. & Mfg. Co.	2,343.00				2,343.00	2,343.00		100	
Machine	July 30, 1915		Westinghouse Trac. Brake Co.	287.50				287.50	287.50		100	
Machine	July 30, 1915		I. G. Brill Company	935.00				935.00	935.00		100	
Machine	July 28, 1915		U. S. Steel Products Co.	38,211.40	Dec. 1, 1915	90		37,146.67	37,146.67		100	
Machine	July 28, 1915		Contra Costa Construction Co. (Trans.)	(Trans.)	as an extra on Cont. No. 23P.							
Machine	July 28, 1915		Contra Costa Construction Co. (Trans.)	(Trans.)	as an extra on Cont. No. 23B.							
Machine	Dec. 1, 1915		U. S. Steel Products Co.	860.00	Dec. 1, 1915	90		880.00	880.00		100	
Machine	Aug. 20, 1915		Navarro Lumber Co.	4,900.00				4,889.69	4,889.69		100	
Machine	Nov. 26, 1915		Kelly-Springfield Mo. Trk. Co.	2,165.00				2,165.00	2,165.00		100	
Machine	Nov. 26, 1915		Ocean Shore Iron Works	1,760.00				1,760.00	1,760.00		100	
Machine	Jan. 19, 1916		John Sparzo	6,590.00	Feb. 3, 1916	21		6,523.41	6,523.41		100	
Machine	Feb. 11, 1916		E. Earle Browne	11,362.00	Feb. 25, 1916	75		11,201.13	11,201.13		100	
Machine	July 5, 1916		U. S. Steel Products Company	16,121.00	July 19, 1916	80		15,355.36	15,355.36		100	
Machine	Jan. 19, 1917		Stan. Underground Cable Co.	16,575.20	Mar. 19, 1917	7		16,253.87	16,253.87		100	
Totals								\$2,629,970.04	\$71,018.46	\$2,684,627.73		\$2,685,586.23

not paid contractor and expenditures for incidentals in connection with the carrying out of the work.

Freight on Railway Materials bought under contract.....	175,692.65
Header Blocks, Chestnut St., Scott to Laguna & Other Lines	6,190.90
Relocating Hydrants on Church Street Right of Way.....	200.00
Incidentals other than Extras Municipal Railways.....	2,171.75
Inspection of Railway Construction & Extensions.....	42,899.77
Inspection of Railways, Church St. Extension.....	14,360.86
Lands, Supervisors' Expenditures.....	78,703.43
Equipment at Pipe Yard.....	3,059.57
Market Street Line, Report of Court Proceedings.....	318.80
Pipe Yard Maintenance, part cost.....	847.37
Plans and Specifications, Church Street Line.....	4,491.75
Plans and Specifications for Municipal Railway.....	109,056.04
Purchase of Presidio & Ferries R. R. Property.....	312,535.32
Handling of Material at Pipe Yard.....	1,200.00
Stockton Street, Removal of U. R. R. Tracks, etc.....	24,978.00
Stockton Street Tunnel Line Excavation.....	4,620.00
Supervisors' Sundries, Municipal Railway Bonds.....	30,878.63
Unloading and storing Material at Pipe Yard.....	18,236.83
Total	\$860,694.08

CONTRACT EXPENDITURES OUT OF MUNICIPAL RAILWAY EARNINGS

TABLE II

No.	Description of Work	Contractor	Date Contract Was Awarded	Date Contract Was Signed	Time Allowed No. of Days	Extension of time granted No. of Days	Expended Prior to July 1, 1917	Expended from July 1, 1917, to July 1, 1918	Amount Expended	Per Cent of Contract Complete	Amount of Award	Date Contract Was Accepted
52	Furnishing & Delivering Track Special Work, Church St. Ry.	U. S. Steel Products Co.	7/5/18	7/19/18	80			\$ 9,232.00	\$ 9,232.00	100	\$ 16,121.00	7/11/17
53	Furnishing & Delivering Underground Conduit Material	H. W. Johns-Manville Co.	4/4/17	7/31/17	4/15/17			2,582.89	2,582.89	100	1,705.73	8/24/17
54	Furnishing & Installing Storage & Distributing Equipment for Gasoline	S. F. Bowser & Co., Inc.	11/5/17	11/19/17	30			1,197.88	1,197.88	100	1,359.76	1/4/18
54	Furnishing & Delivering Steel Rails & Rail Joints for T. P. Tun. Line, Mkt. L.	U. S. Steel Products Co.	8/18/18	9/2/18	300		87,049.11	85.27	87,185.38	100	* 22,550.00	7/15/17
57	Construction of Potrero Ave. Extension, 25th St. to Army Street	Eaton & Smith	10/28/16	11/4/18	40	30	7,171.77	71.00	7,245.77	100	8,380.00	1/31/17
58	Furnishing & Delivering Five Automobile Buses	The White Company	2/19/17	3/8/17	120	220		28,345.05	28,345.05	100	29,550.00	1/4/18
59	Furnishing & Delivering Electrical Cables & Splicing Material, T. P. Tun. Line	Standard Underground Cable Co.	1/5/17	1/13/17	8/31/17		15,180.87	15,912.20	82,008.83	100	82,125.71	9/12/17
60	Furnishing & Delivering Wood Ties	A. F. Mahoney	5/7/17	5/31/17	7/15/17		11,550.00	5,995.45	18,545.45	100	18,480.45	12/14/17
91A	Furnishing & Delivering Tie Plates, Rail Braces, R. Spikes, T. Rods, Anti-Cre.	Eccles & Smith Co.	3/23/17	4/7/17	7/15/17		11,880.15		11,880.15	100	11,380.15	7/6/17
91B		Eccles & Smith Co.	3/23/17	4/7/17	7/15/17			1,125.00	1,125.00	100	1,125.00	5/15/17
91C		Payne's Bolt Works	2/28/17	4/11/17	7/15/17			1,593.00	1,593.00	100	1,593.00	5/13/17
91D		U. S. Steel Products Co.	3/23/17	4/12/17			3,310.14		8,319.14	100	8,367.50	5/15/17
91E		U. S. Steel Products Co.	8/23/17	4/12/17								
92	Furnishing & Delivering Copper Trolley Wire	Telephone Electrical Equip. Co.	2/19/17	2/27/17	5/30/17		13,741.88		13,741.88	100	18,702.00	5/20/17
93	Furnishing & Delivering Track Special Work	U. S. Steel Products Co.	8/29/17	9/18/17	110			51,507.00	51,507.00	100	51,507.00	4/3/18
94	Furnishing & Delivering Electric Cables & Splicing Materials	Standard Underground Cable Co.	3/19/17	4/4/17	7/30/17			4,850.89	4,869.80	100	**16,576.20	5/4/18
95	Construction Twin Peaks Tunnel Line	Eaton & Smith	6/22/17	7/7/17	150	90		88,815.17	86,815.17	100	80,457.23	3/1/18 as of 12/23/17
96	Construction Market St. Line, Church St. to Castro St.	James M. Smith	5/31/17	9/15/17	00	80		87,805.94	87,805.94	100	36,959.78	5/20/18
97	Construction Market St. Outer Tracks, Geary St. to Van Ness Ave.	Western Contracting Co.	2/5/18	2/14/18	120			137,194.55	137,194.55	100	130,808.31	5/7/18 Conditional
99	Installing Electrical Conductors and Appurtenances	H. S. Tittle	10/28/17	11/18/17	Sec. A 12/1/17 Sec. B 2/1/18			4,824.94	4,524.94	100	3,839.00	6/19/18
100A&D	Furnishing & Delivering Steel Rails, Rail Joints & Fastenings	U. S. Steel Products Co.	12/14/17	12/22/17	1/15/18			42,888.50	42,658.50	100	42,840.55	5/5/18
100B	Furnishing & Delivering Steel Rails, Rail Joints & Fastenings	Eccles & Smith Co.	12/14/17	12/31/17	1/15/18			5,250.00	5,250.00	100	5,250.00	2/18/18
100C	Furnishing & Delivering Steel Rails, Rail Joints & Fastenings	Payne's Bolt Works	12/14/17	12/25/17	1/15/18			1,238.78	1,238.78	100	1,240.00	6/19/18
101	Furnishing & Delivering Wood Ties	J. H. Baxter & Co.	12/14/17	12/28/17	2/1/18			5,425.52	5,425.82	100	5,580.00	3/13/18
102	Construction of Greenwich St. Line, Scott to Baker St.	Eaton & Smith	2/25/18	3/12/18	90			29,000.00	29,000.00	100	28,500.00	5/15/18
							\$130,398.22	\$483,543.62	\$813,941.81		\$578,118.95	

* Estimated bid price did not include Market St. Rails & Rail Joints.

** Balance paid out of 1913 Bond Fund.

IV. Expenditures out of Municipal Railway Earnings other than by Formal Contract.

V. Summary of all Expenditures to July 1, 1918.

VI. Statement of 1913 Railway Bond Fund, Summary, July 30, 1918.

OTHER THAN CONTRACT EXPENDITURES—TABLE III.

Made Out of 1913 Bond Issue

Assembling and Transporting Street Cars.....	\$ 6,824.79
Automobile for Bureau of Engineering.....	686 30
Bonding Rails for Church Street Line.....	1,379.44
Bonding Crossings of U. R. R.....	4,685.17
Reconstruction of U. R. R. Branch-offs and Crossings at California, Cornwall St. and 6th Avenue.....	1,400.00
Chestnut Street, Reconstruction of Tracks.....	2,223.71
Church Street Line, Appraisal of land for Right of Way.....	1,000.00
Church Street Line, Condemnation of Rights of Way.....	1,431.90
Church Street Line, Drilling Test Holes in R. O. W.....	199.00
Church Street Line, Purchase of Rights of Way.....	6,533.00
Church Street Line, Narrowing Sidewalks.....	2,517.66
Extra Parts & Equipment, Union St. Railway.....	1,371.44
Freight on Railway Materials bought under contract.....	175,692.65
Header Blocks, Chestnut St., Scott to Laguna & Other Lines	6,190.90
Relocating Hydrants on Church Street Right of Way.....	200.00
Incidentals other than Extras Municipal Railways.....	2,171.75
Inspection of Railway Construction & Extensions.....	42,899.77
Inspection of Railways, Church St. Extension.....	14,360.86
Lands, Supervisors' Expenditures.....	78,703.43
Equipment at Pipe Yard.....	3,059.57
Market Street Line, Report of Court Proceedings.....	318.80
Pipe Yard Maintenance, part cost.....	847.37
Plans and Specifications, Church Street Line.....	4,491.75
Plans and Specifications for Municipal Railway.....	109,056.04
Purchase of Presidio & Ferries R. R. Property.....	312,535.32
Handling of Material at Pipe Yard.....	1,200.00
Stockton Street, Removal of U. R. R. Tracks, etc.....	24,978.00
Stockton Street Tunnel Line Excavation.....	4,620.00
Supervisors' Sundries, Municipal Railway Bonds.....	30,878.63
Unloading and storing Material at Pipe Yard.....	18,236.83
Total	\$860,694.08

EXPENDITURES OUT OF MUNICIPAL EARNINGS
OTHER THAN BY FORMAL CONTRACT—TABLE IV.

Church Street bet. 18th & 19th, paving.....	\$ 3,121.47
Church Street & 18th, Feeder Connection.....	284.00
Greenwich Street, Scott to Baker, Inspection.....	1,230.84
Hampshire St., Front of 17th St. Car Barn, Sewer.....	495.00
Westerly half Hampshire St. to Mariposa St., Paving.....	3,023.97
Laguna Honda Sta., Twin Peaks Tunnel, Elec. Fixtures	640.00
Mariposa Street, York to Hampshire, Paving.....	1,100.00
Oil Pumps & Tank Geary St. Car Barn, Auto Bus Service	211.75
Overhead Electric Trolley Work, Market St. Outer Tracks	1,358.66
Plans, Market St. from T. W. Tunnel to Geary & Market	9,899.27
Plans, Greenwich St., Scott to Baker Streets.....	865.50
Potrero Ave. Ry., 25th to Army Sts., Miscellaneous.....	562.12
Projected Extensions, Municipal Rys., Investigation and Report	4,854.12
Tax Refunds, Church Street Right of Way.....	549.70
21st Street, Church to Chattanooga Streets.....	342.90
Twin Peaks Tunnel, Permanent Lighting, Cables & Fix- tures	12,000.00
Unloading & Handling Ry. Materials, Market Street and Twin Peaks Tunnel Lines.....	3,357.53
Automobile Bus Body, Plans & Specifications.....	420.75
Purchase of 5 Automobile Bus Chassis.....	18,900.50
Bonding Rails, Market Street Line, Van Ness to Geary....	591.04
Bonding U. R. R. Crossings, Market Street Line.....	3,536.76
Freight on Railway Materials.....	21,433.89
Header Blocks for Market & Greenwich St. Lines.....	2,750.00
Incidentals other than Extras, Twin Peaks, Market and Greenwich Lines	520.34
Inspection of Materials, Market St., Geary to Van Ness and Church Street to Twin Peaks Tunnel.....	88.49
Rearranging Traffic Signals, Kearny, Market & 3d Sts....	130.95
Market St., Van Ness to Geary & Church to Castro, Insp.	7,844.82
Plans and Specifications for Taraval Street Line.....	956.10
Plans and Specifications for Twin Peaks Tunnel Line.....	4,855.78
Plans, Twin Peaks Tunnel Line Extension Westerly.....	766.15
Plans and Specifications for Union St. Line, Car.....	45.00
Rights of Way, Twin Peaks Tunnel Line.....	1,093.75
United Railroads Valuation.....	321.40
	<hr/>
	\$108,152.55

MUNICIPAL RAILWAY SYSTEM
SUMMARY OF ALL CAPITAL EXPENDITURES—TABLE V.

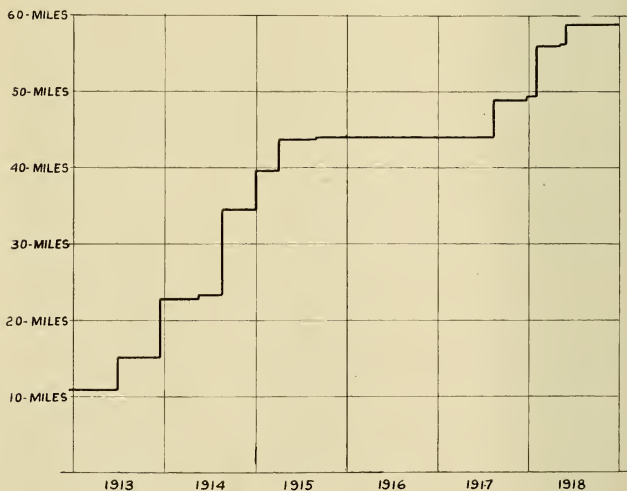
June 30, 1918

	1910 Bond	1913 Bond	Municipal Railway Fund	Total
Track Materials	237,417.52	625,298.23	253,299.91	1,116,015.66
Track Construction	601,214.04	1,121,202.62	337,896.79	2,060,313.45
Electrical Materials	38,239.88	57,768.51	53,293.09	149,301.48
Electrical Construction	92,791.19	234,685.11	22,395.40	349,871.70
Street Cars	355,808.99	774,154.37	45.00	1,130,008.36
Car Barns	450,742.87	258,283.28	5,533.05	714,559.20
Shop Equipments	21,423.87	9,766.66	.....	31,190.53
Real Estate, Right of Way & Legal	163,814.14	152,582.30	1,643.45	318,039.89
Railways Purchased	21,577.24	312,535.32	321.30	334,433.96
Automobile Buses .....	.....	.....	47,666.30	47,666.30
Total	\$1,983,029.74	\$3,546,276.40	\$722,094.39	\$6,251,400.53

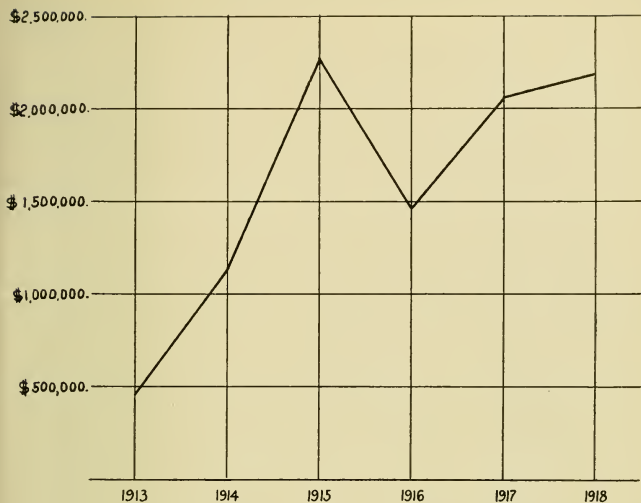
STATEMENT OF 1913 RAILWAY BOND FUND
SUMMARY—TABLE VI.

June 30, 1918

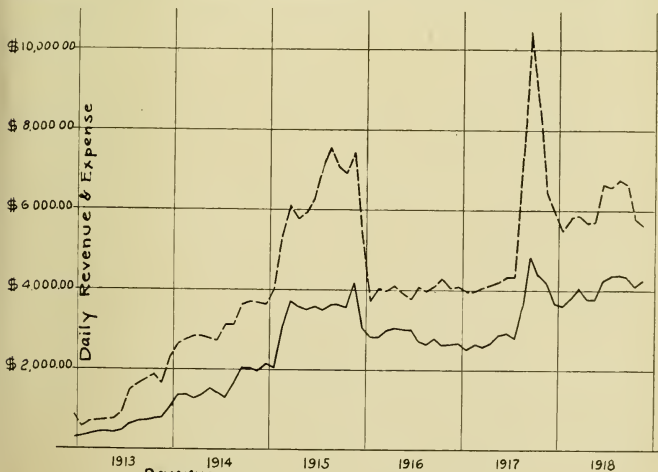
Total Bonds authorized and sold.....	\$3,500,000.00
Premiums	23,658.88
Received from Ocean Shore Ry. Co. as part cost of Potrero Avenue Line.....	33,717.97
Received from sale of buildings.....	1,662.95
<hr/>	
Total money available.....	\$3,559,039.80
Total expended to June 30, 1918.....	3,546,276.40
<hr/>	
Balance in Fund.....	\$ 12,763.40



CURVE- SHOWING GROWTH OF MUN RAILWAY SYSTEM
SINGLE TRACK MILEAGE OPERATED EACH YEAR



GROSS ANNUAL RECEIPTS OF MUN. RAILWAY



Operating Revenue of Mun. Railway—Monthly Averages -----
 Operating Expense of Mun. Railway—Monthly Averages —————

HETCH HETCHY WATER SUPPLY

During the past fiscal year, despite the numerous difficulties incident to war time construction, work on the Hetch Hetchy project has continued without interruption.

Difficulty in securing skilled labor, advances in the cost of construction material, and the fact that the Board of Supervisors did not promptly act on the recommendation of the City Engineer, made in January, 1917, to sell immediately sufficient bonds to allow of the rapid completion of the Mountain Division of this project, have all tended to retard the program outlined by the City Engineer in his previous reports; but considering the amount of money available, which was less than one and one-half million dollars, much has been accomplished on the project.

General Administration:

During the latter part of the fiscal year, heavy drafts for service in the U. S. Army and Navy were made on the Hetch Hetchy engineering and clerical force. So difficult was it to obtain competent technical and clerical assistants in the mountains, with the very poor living conditions that existed in Tuolumne County, that it was deemed advisable for the City to construct suitable living quarters at Groveland, the headquarters of the Mountain Division, to accomodate such assistants.

An adequate frame building, containing 13 rooms, suitably furnished and provided with kitchen, living room, bath, showers, etc., was completed at a cost of about \$7000, for use of which a monthly rental for rooms is charged.

It was deemed essential to provide medical attention for the men engaged on the Hetch Hetchy Project. For this purpose a main hospital building was erected at Groveland, close to the Hetch Hetchy Railroad.

This is a two story structure. The lower floor contains office, one ward with a capacity of seven beds, two bedrooms, bath, dining room and kitchen. On the second floor is an operating room, sterilizing room, ward for the accomodation of eight patients, X-ray room, two bedrooms and two baths. The building is provided with electricity and steam heat and will contain all the equipment of a first-class modern hospital.

Ordinance No. 4248 of the Board of Supervisors, adopted July 10, 1917, authorizes the Board of Public Works to make such arrangement or enter into such contracts as the said Board may deem advisable to insure the proper protection and care of the health and safety of all persons employed on the Hetch Hetchy Project; to enter into agreements for the procurement of the proper medical, surgical and hospital attendance for any employee who may become sick or injured while engaged on work for the City, whether such employee be hired by the City and County of San Francisco or any contractor or sub-contractor thereof, provided that the Board of Public Works be reimbursed by any contractor or sub-contractor for the expense of medical, surgical or hospital attendance furnished to the employees of such contractor or sub-contractor.

Acting under the authority provided by this Ordinance, a contract was entered into between the City and Dr. E. T. Gould, of Sonora, Tuolumne County. Under the provisions of this contract the City pays to Dr. Gould \$1.00 per month per capita and proportionate amounts for fractions of months, for each and every employee engaged in the construction of the Hetch Hetchy Project in the Counties of Tuolumne and Mariposa. It is agreed that in consideration of this compensation, the hospital building at Groveland will be equipped and maintained for City employees by the contracting surgeon, Dr. Gould. A competent, licensed physician and surgeon will be employed to take charge of this hospital, and furnish a

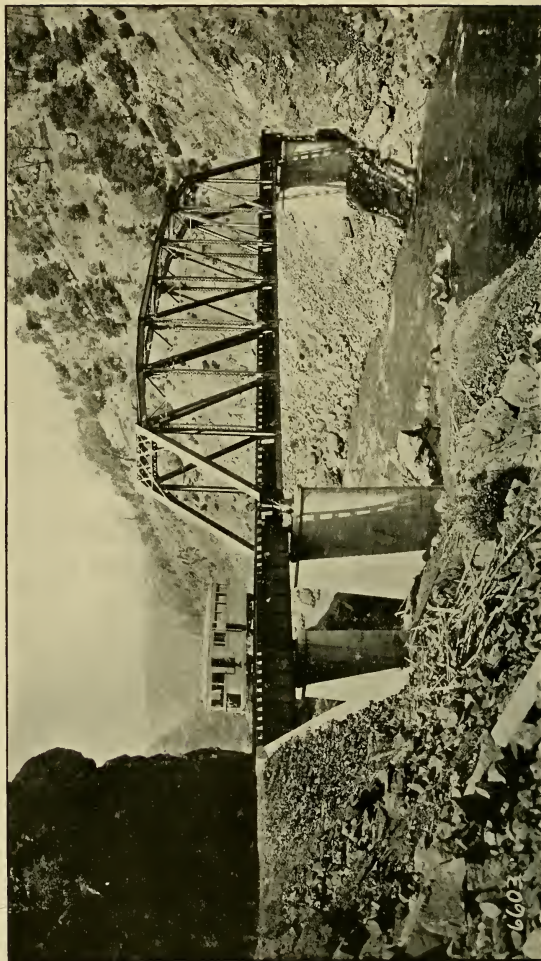
graduate nurse, kitchen department, and all drugs, dressings and surgical appliances that may be required for the proper care of the sick and injured. The same are cared for at the expense of the contracting surgeon. In case of serious illness or injuries where recovery is apt to be protracted, patients are removed from the base hospital at Groveland to a larger hospital maintained by the contracting surgeon at Sonora, California, where they are treated and furnished board and lodging until recovery, except in cases of permanent injury or fatal diseases, when the obligation of the contracting surgeon to board and care for such patients ceases at the expiration of six months, unless such time is extended by order of the Industrial Accident Commission, as provided by law. During periods of convalescence, the contracting surgeon furnishes drugs, dressings and professional attendance, but not board and lodging. Under this provision would be included cases of amputation of fingers, fractures of small bones, and minor injuries not incapacitating the patient from caring for himself.

To guard against epidemics in City camps, all prospective employees must undergo a physical examination, which is made under the terms of the contract by the contracting surgeon without charge to the City or to the prospective employee.

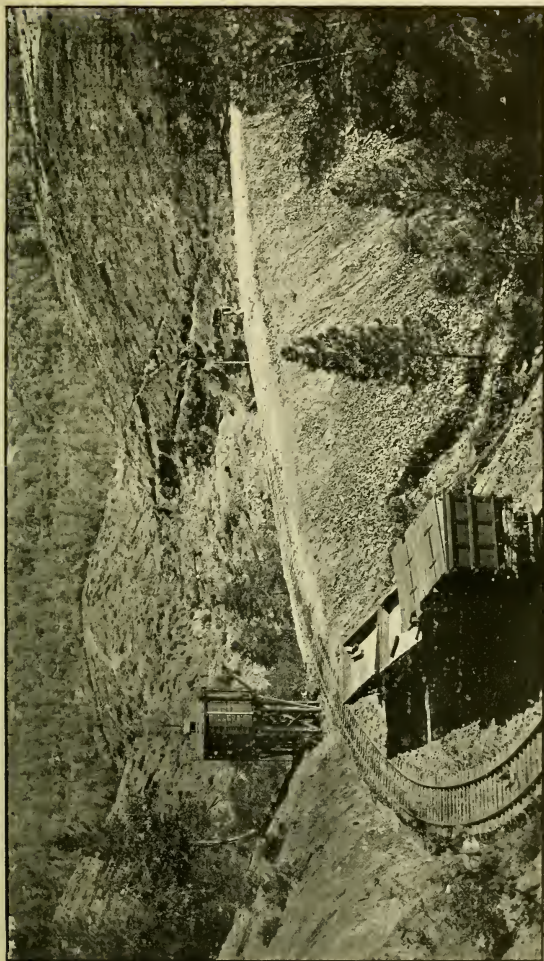
Where the services of a specialist are required, the same must be furnished at the expense of the contracting surgeon.

This contract can be cancelled at the option of the Board of Public Works, in which case provision would be made for employing a competent surgeon and medical staff.

Beside providing hospital conveniences and medical treatment, all men engaged in Tuolumne County on the Hetch Hetchy Project are insured with the State Compensation Insurance Fund. The following are the premium rates per \$100 paid on the various classes of labor:



Tuolumne Bridge—Hetch Hetchy Railroad



Priest Regulating Reservoir Site

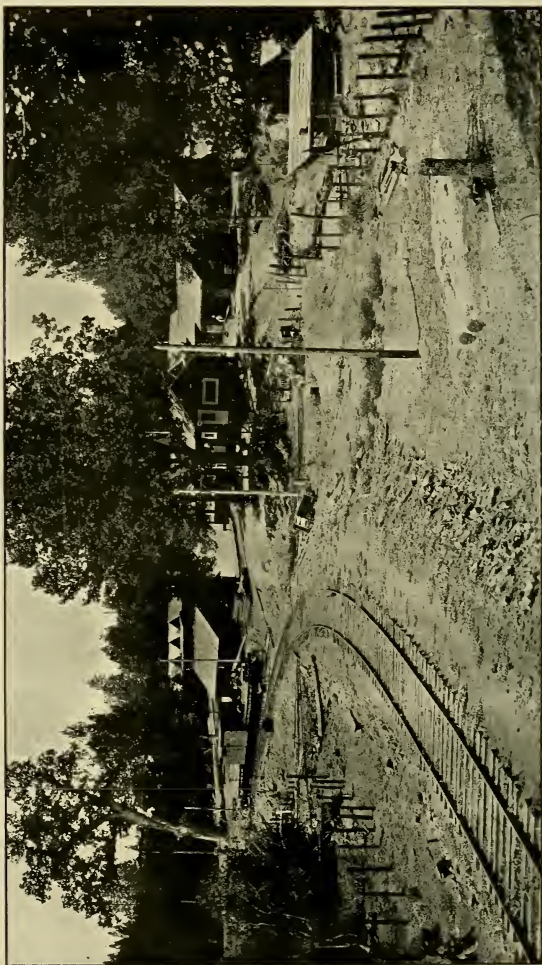
Surveying and Inspecting Engineer work—including shop work incident to surveying and inspection of construction operations, but not including actual construction work or superintendence of same.....	\$.72
Commissary Work.....	1.232
Saw Mills	4.224
Logging and Lumbering—including transportation of logs to mill, but not including mill operation.....	5.074
Waterworks—construction of pumping stations, dams and reservoirs	6.10
Tunneling—including all work to completion, (Special Rate)	7.327
Blasting—includes storage, handling and use of explosives, also loading, capping and firing.....	18.40
Road or Street Making and Repairing—includes operation of road-making machinery, trucks, etc.....	2.541
Railroad Construction—steam, electric, horse or cable.....	4.624
Bridge Building—wood (no blasting).....	6.987
Masonry or Concrete Work.....	2.43
Carpentry—including interior trim and cabinet work.....	2.031
Cellar Excavating	2.43
Shop Employees (Railroad).....	2.312
Clerical Office Employees (Railroad).....	.093
All Other Employees (Railroad).....	6.987
Electric Light and Power Line—construction work exclusively—on transmission lines not intended for local distribution	4.853
Electric Light and Power Companies—operation, maintenance, extension of lines and making of service connections	4.853
Electrical Apparatus—erection and repair work only, including installation of equipment, etc.....	1.462
Canals—construction	5.304
Fence construction (wood, stone, metal or concrete).....	2.116
Farming and-or Ranching.....	1.547
Flume Construction	6.987
Janitors	1.003
Millwright Work—erection and repair of machinery.....	2.43
Stone Crushing (no quarrying).....	4.624
Telegraph and Telephone Construction.....	2.915
Shaft Sinking	11.594

The above rates are approximately 15% lower than the regular rates. This reduction was made by the State Compensation Fund on account of the establishment of the hospital on the work.

The City has exercised every precaution in safeguarding the lives and health of its employees, and so far has been exceedingly fortunate in eliminating accidents, only two fatalities having occurred in four years. Considering the number of men employed and the dangerous character of the work, this has been a good record, but despite the utmost precaution, serious accidents are common on construction work, and for this reason it is deemed best to carry Compensation Insurance with the State.

On a project of this magnitude, it was necessary to inaugurate a comprehensive system of accounts. This necessarily must be capable of ready coordination with the Interstate Commerce Commission and the Railroad Commission of the State of California system of accounting, because it will be necessary to render annual reports on this utility to the latter Commission. At the same time it was necessary to formulate a system which is readily adaptable to the present work and capable of expansion to cover every division of the future work. The same had necessarily to be coordinated also with the system in use for the past five years by the Bookkeeper of the Board of Public Works. The basis of the system formulated by the City Engineer is as follows:

Accounts are divided into two classes, namely, main accounts and sub-accounts. The main accounts are designated by number and refer to main divisions of the Hetch Hetchy work; the sub-accounts are designated by letter of the alphabet. All expenditures on the entire Mountain Division of the project may easily be classified under a sub-account, which in turn is allocated under a main account. For instance, if a car of oil was purchased for fuel for a locomotive engaged in ballasting the Hetch Hetchy Railroad, the same would be charged under account No. ⁸¹¹~~812~~-(d), in the following tabulation of main and sub-accounts:



Big Creek Camp



South Fork Camp

Main Accounts:

No.

1. Preliminary Water Supply Investigation.
2. Lands, Water Rights and Rights of Way.
3. Rentals to United States Government.
4. Legal Expenses.
5. Hydrography.
6. City Office Administration.
7. City Office Engineering.
8. Revolving Fund of City Engineer.
9. Revolving Fund of Special Counsel.
101. Groveland Office Administration and Engineering.
102. Groveland Hospital.
110. Groveland Dwellings.
201. Hetch Hetchy Division Preliminary Investigation and Surveys..
202. Hetch Hetchy Division Engineering.
203. Hetch Hetchy Division Camps.
204. Hetch Hetchy Division Roads, Trails and Tramways.
205. Hetch Hetchy Dam and Appurtenances.
206. Clearing Hetch Hetchy Reservoir.
301. Lake Eleanor Division Preliminary Investigations and Surveys.
302. Lake Eleanor Division Engineering.
303. Lake Eleanor Division Camps.
304. Lake Eleanor Division Roads, Trails and Tramways.
305. Lake Eleanor Dam and Appurtenances.
306. Clearing Lake Eleanor Reservoir.
401. Aqueduct Tunnels Mountain Division Preliminary Investigations and Surveys.
402. Aqueduct Tunnels Mountain Division Engineering.
403. Aqueduct Tunnels Mountain Division Camps.
404. Aqueduct Tunnels Mountain Division Roads, Trails and Tramways.
405. Aqueduct Adits Mountain Division.
406. Aqueduct Shafts Mountain Division.
501. Priest Division Preliminary Investigations and Surveys.
502. Priest Division Engineering.
503. Priest Division Camps.
504. Priest Division Roads, Trails and Tramways.
505. Priest Dam and Appurtenances.
506. Clearing Priest Reservoir.
507. Priest Outlet Tunnel.
601. Moccasin Creek Division Preliminary Investigations and Surveys.

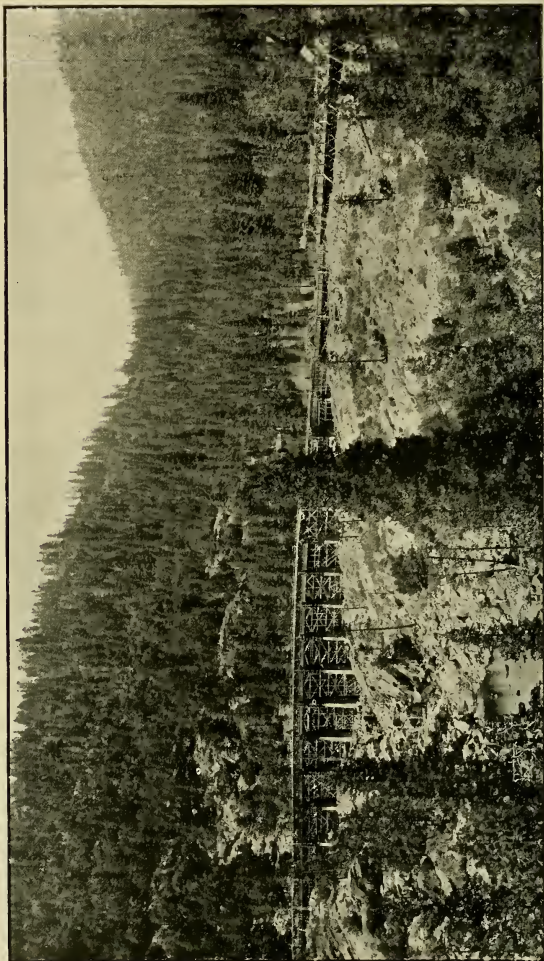
- 602. Moccasin Creek Division Engineering.
- 603. Moccasin Creek Division Camps.
- 604. Moccasin Creek Division Roads, Trails and Tramways.
- 605. Moccasin Creek Division Lands Devoted to Electrical Pur-
Purposes.
- 606. Moccasin Creek Penstock.
- 607. Moccasin Creek Power Plant Buildings and Structures.
- 608. Moccasin Creek Power House Hydraulic Equipment.
- 609. Moccasin Creek Power House Electrical Equipment.
- 613. Moccasin Creek Power House Miscellaneous Equipment.
- 701 to 799 inclusive: Reserved for Foothill Division.
- 801. Hetch Hetchy Railroad Engineering.
- 802. H. H. R. R. Land for Transportation Purposes.
- 803. H. H. R. R. Grading.
- 806. H. H. R. R. Bridges, Trestles, and Culverts.
- 807. H. H. R. R. Elevated Structures.
- 808. H. H. R. R. Ties.
- 809. H. H. R. R. Rails.
- 810. H. H. R. R. Other Track Material.
- 811. H. H. R. R. Ballast.
- 812. H. H. R. R. Track Laying and Surfacing.
- 813. H. H. R. R. Right-of-way Fences.
- 815. H. H. R. R. Crossings and Signs.
- 816. H. H. R. R. Station and Office Buildings.
- 817. H. H. R. R. Roadway Buildings.
- 818. H. H. R. R. Water Stations.
- 819. H. H. R. R. Fuel Stations.
- 820. H. H. R. R. Shops and Enginehouses.
- 822. H. H. R. R. Storage Warehouses.
- 826. H. H. R. R. Telegraph and Telephone Lines.
- 827. H. H. R. R. Signals and Interlockers.
- 835. H. H. R. R. Miscellaneous Structures.
- 837. H. H. R. R. Roadway Machines
- 838. H. H. R. R. Roadway Small Tools.
- 839. H. H. R. R. Assessments for Public Improvements.
- 840. H. H. R. R. Revenues and Operating Expenses during Con-
struction.
- 841. H. H. R. R. Cost of Road Purchases.
- 842. H. H. R. R. Reconstruction of Road Purchased.
- 843. H. H. R. R. Other Expenditures—Road.
- 844. H. H. R. R. Shop Machinery.
- 847. H. H. R. R. Unapplied Construction Materials and Supplies.
- 851. H. H. R. R. Steam Locomotives.
- 852. H. H. R. R. Other Locomotives.
- 853. H. H. R. R. Freight-Train Cars.

- 854. H. H. R. R. Passenger-Train Cars.
- 855. H. H. R. R. Motor Equipment of Cars.
- 856. H. H. R. R. Floating Equipment.
- 857. H. H. R. R. Work Equipment.
- 858. H. H. R. R. Miscellaneous Equipment.
- 871. H. H. R. R. Organization Expenses.
- 872. H. H. R. R. General Officers and Clerks.
- 873. H. H. R. R. Law.
- 874. H. H. R. R. Stationery and Printing.
- 875. H. H. R. R. Taxes.
- 876. H. H. R. R. Interest During Construction.
- 877. H. H. R. R. Other Expenditures—General.
- 900 to 1000: Hetch Hetchy Railroad Revenue Account (as per I. C. C. Classification).
- 1001 to 2000: Hetch Hetchy Railroad Operating Expenses (as per I. C. C. Classification).
- 2001. Lower Cherry Power Development Preliminary Investigations and Surveys.
- 2002. L. C. P. D. Engineering.
- 2003. L. C. P. D. Camps.
- 2004. L. C. P. D. Roads, Trails and Tramways.
- 2005. L. C. P. D. Lands Devoted to Electrical Operations.
- 2006. L. C. P. D. Penstock.
- 2007. L. C. P. D. Power Plant Buildings and Structures.
- 2008. L. C. P. D. Hydraulic Power Plant Equipment.
- 2014. L. C. P. D. Transmission Line Poles and Fixtures.
- 2015. L. C. P. D. Transmission Line Overhead Construction.
- 2016. L. C. P. D. Clearing Transmission Line.
- 2017. L. C. P. D. Transmission Line Substation Buildings and General Structures.
- 2018. L. C. P. D. Transmission Line Substation Equipment.
- 2019. L. C. P. D. Transmission Line Miscellaneous Equipment.
- 2020. L. C. P. D. Transmission Line Transformers and Devices.
- 2040. L. C. P. D. Revenue.
- 2070. L. C. P. D. Operating Expenses.
- 3001. Canyon Ranch Sawmill Preliminary Investigations and Surveys.
- 3002. Canyon Ranch Sawmill Engineering.
- 3003. Canyon Ranch Sawmill Camps.
- 3004. Canyon Ranch Sawmill Roads, Trails and Tramways.
- 3040. Canyon Ranch Sawmill Revenue Account.
- 3070. Canyon Ranch Sawmill Operating Expenses.
- 4000. Boarding House.
- 5000. Warehouse and Stores.

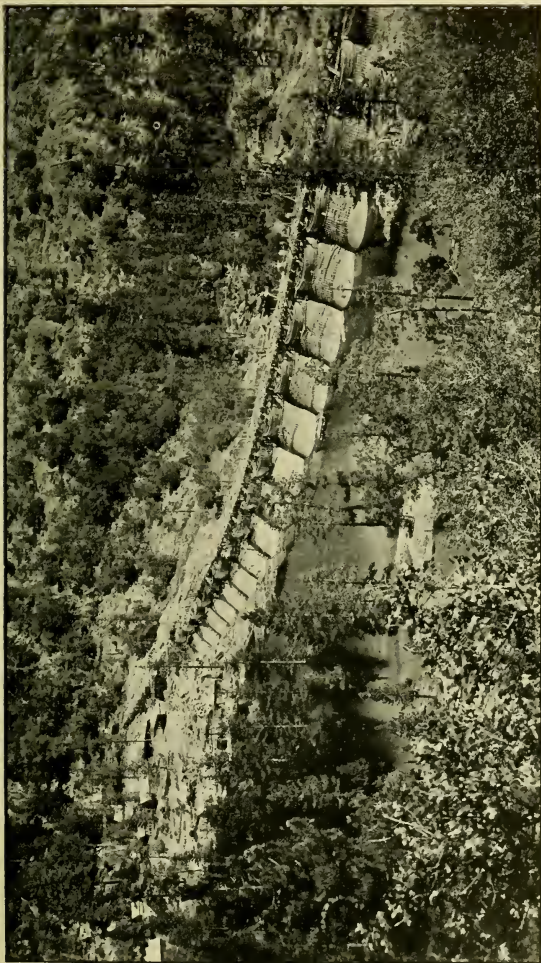
Sub-Accounts:

- (a) Salaries and Wages.
- (b) Construction Equipment: Including machinery; tools; engineering instruments; automobiles owned by City; office furniture; hospital furniture; etc.
- (c) Construction Materials: Including all materials that remain in finished structures but not those that disappear or are completely consumed during construction or removed after construction.
- (d) Consumable Supplies: Including stationery; postage; rent; light; heat; telephone messages; telegrams; printing; lumber; fuel; etc.
- (e) Traveling Expenses: Including railroad fare; auto hire; auto mileage on privately owned automobiles; hotel bills; meals while traveling; gasoline or oil for City owned autos; etc.
- (f) Insurance.
- (g) Damages to Persons and Property.
- (h) Timber Payments.
- (i) Subsistence of Employees.
- (j) Contracts.

Due to present war conditions, much difficulty has been experienced in securing material for this project. Many manufacturing plants are operating on Government contracts and refuse to bid on municipal work. Frequently, material ordered by the City was commandeered by the Government. It was therefore necessary to recommend to the Board of Supervisors special legislation, in order that the Board of Public Works could be authorized by Ordinance legally to proceed with the construction, and still be as much as possible unhampered by senseless restrictions in ordering and paying for supplies and construction equipment. Accordingly, on the recommendation of the City Engineer, an Ordinance was adopted on January 21, 1918, authorizing the Board of Public Works to purchase supplies, materials or equipment in the open market at the lowest obtainable price in any case where bids were called for and none received, or where bids were identical in amount and rejected by the Board of Public Works, or where the articles, supplies,



Downstream View of Lake Eleanor Dam



Upstream View of Lake Eleanor Dam

material or equipment sought to be purchased or acquired are entirely owned or controlled by one person, firm or corporation, and no satisfactory substitute therefor exists.

Further to facilitate the securing of supplies under adverse conditions, it is the intention of the City Engineer to recommend to the Board of Supervisors the adoption of the following Ordinance:

"Whenever in the construction of the Hetch Hetchy project the Board of Public Works shall require materials or equipment for use in such construction, the demand for which is so affected by the present war conditions that the manufacturers or sellers of the same are unwilling to submit formal bids for furnishing such materials or equipment, or the demand for such materials or equipment is so urgent that preparation of specifications and calling for formal bids would result in a delay which might make it impossible to procure the desired materials or equipment, and the Board of Public Works expressly finds, after due investigation, that such a condition exists with respect to the particular materials or equipment required, then and in such event, and during the period of the war emergency only, the Board of Public Works is authorized to purchase such materials or equipment without requiring formal bids to be submitted; provided, that in all such cases the Board of Public Works shall purchase such material or equipment from that person, firm or corporation which shall informally submit the lowest bid therefor."

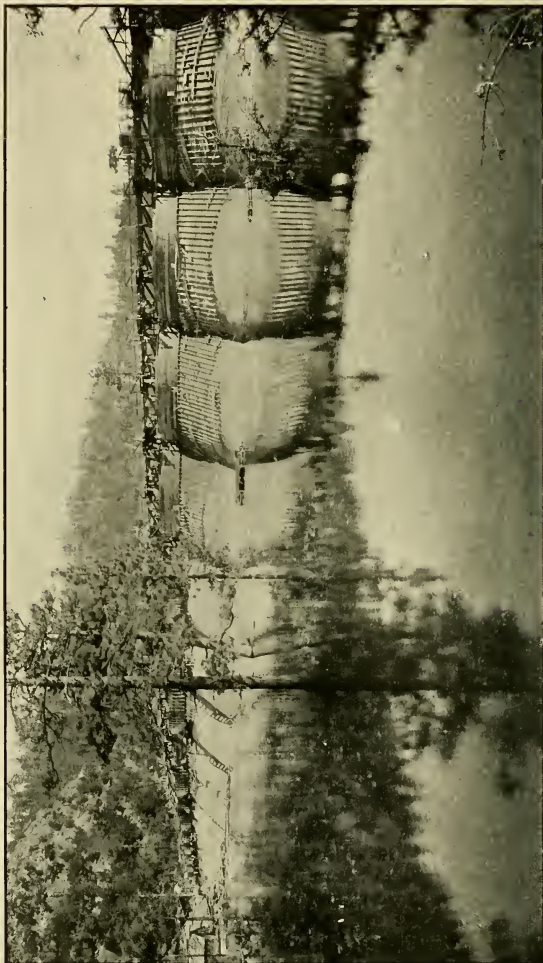
In order to obtain a ruling of the Court and assure himself of the validity of the procedure under which material and equipment for the Hetch Hetchy Project is now purchased, the City Engineer advised that one of the dealers supplying material to the Hetch Hetchy Project bring a mandamus suit to compel the Auditor to pay his demand on the City Treasury therefor. The suit was brought by Edward L. Soule, who supplied corrugated reinforcing steel for use in the Eleanor Dam. The following is an excerpt from the decision of Judge Nourse, to whose Court the case was assigned:

"The case here presented is one involving the right of the Board of Public Works to purchase materials for use in the construction and operation of a public utility, to-wit, the Hetch Hetchy Water Supply. The power of the City to acquire, construct or conduct such a utility is found in Section 14 of Article XII of the

Charter. By subdivision 8 of Section 9 of Chapter I of Article VI of the Charter the Board of Public Works is given charge, superintendence and control under such ordinances as may be from time to time adopted by the Supervisors of any and all public utilities owned, controlled or operated by the City. The pleadings are silent as to the adoption of any ordinance by the Board of Supervisors in relation to the authority of the Board of Public Works in connection with the Hetch Hetchy water project, but the petition alleges that these materials were duly purchased and contracted for by the Board of Public Works, and this allegation is admitted by the defendant. It is fair to assume, therefore, that the Board of Public Works is, in the construction of the Hetch Hetchy water project, acting under a valid and existing ordinance of the Board of Supervisors adopted in accordance with the provisions of the Charter above noted.

"It has been suggested that the provisions of Section 31 of Chapter 2 of Article VI of the Charter requiring the Board of Public Works to invite proposals for supplying to the City and County such materials as may be required for the repair of public streets or improvements thereof are applicable here, but a reading of that section will show that it is confined solely to work done in connection with the repair and improvement of public streets. It may also be claimed that by reason of the provisions of section 38 of Chapter 2 of Article II of the Charter the Board of Supervisors and not the Board of Public Works is authorized to enter into contracts for the purchase of materials of this nature. This section is permissive in its nature and authorizes the Board of Supervisors to provide for and regulate the purchase of all supplies for the various departments, and also authorizes the Board of Supervisors to establish a Bureau of Supplies, which bureau, when so established, may furnish all supplies or materials required by any officer or department of the City and County. Assuming from the admissions in the pleadings that no such bureau has been established, then the Board of Supervisors may by ordinance authorize the Board of Public Works to purchase such supplies and material as it may deem necessary for the work of its department under such conditions and regulations as the Board of Supervisors by ordinance may prescribe.

"Inasmuch as none of the provisions of the Charter requiring the solicitation of competitive bids apply to the purchase of supplies and materials to be used by the Board of Public Works in connection with the construction of a public utility, such as the Hetch Hetchy water project, it is necessary for the defendant to show that such competitive bids are required by reason of the provisions of some ordinance of the Board of Supervisors. If,



Lake Eleanor Dam

therefore, any such ordinance exists it is necessary for the defendant to plead it, because the Court is not authorized to take judicial notice of ordinances of the City and County. Since it could be by reason of such an ordinance only that competitive bids would be required before the contracts here involved could be entered into, in the absence of such a showing it must be deemed that they were properly executed, and a peremptory writ should accordingly issue requiring the defendant to audit and approve all of the demands of the plaintiff set forth in his complaint which have not heretofore been audited and approved by him."

Despite this decision and interpretation of the City Charter, a decision directly contradictory to the above was recently rendered by another department of the Superior Court. The Supreme Court was appealed to to set aside the same, and reversed the views of this Judge. An adverse decision would have stopped the work on every City project, since it would have held, in effect, that no materials or supplies can be purchased by the City except under annual contract by the Board of Supervisors. It would be manifestly impossible for the Supervisors, under annual contract, to purchase all of the equipment necessary for the Hetch Hetchy Project. No human agency could foresee for months in advance what equipment or spare parts thereof might be necessary as the work progresses.

When the new City Charter was adopted in 1900, no provision was made therein for the construction of public utilities of the magnitude of the Hetch Hetchy Project.

To facilitate the administration of this work and render impossible conflicting Court decisions as above noted, the following Charter amendments have been suggested by the City Engineer:

Article III, Chapter I, Section 10:

"No contracts made, the expense of whose execution is not provided by law or ordinance to be paid by assessments upon the property benefited, shall be binding or of any force unless the Auditor shall indorse thereon his certificate that there remains unexpended and unapplied, as herein provided, a balance of the appropriation or fund applicable thereto, sufficient to pay the estimated expense of executing such contract, as certified by the board

or officer making the same; provided that where the expense of executing such contract is to be paid entirely from the proceeds of bond issues, the requirements of this section may be satisfied through an indorsement by the Auditor that a sufficient number of bonds have been set aside to be sold as payments under the contract fall due, and from the proceeds of which sale the estimated expense of executing such contract may be paid, as certified by the board or officer making the same. This requirement shall not apply to work done, or supplies furnished, involving the expenditure of less than two hundred and fifty dollars, unless the same is required by law to be done by contract at public letting. The Auditor shall make such indorsement upon every such contract so presented to him, if there remains unapplied and unexpended such amount of money or bonds so specified by the officer making the contract, and thereafter shall hold and retain such amount of money or bonds for the purpose of paying the expense incurred until the contract shall be fully performed. If bonds are withheld arrangements shall be made prior to the Auditor's indorsement for the sale of such bonds in such amounts and at such periods of time as will enable the Treasurer to make payments in cash under such contract as such payments fall due and are approved. The Auditor shall furnish weekly to the head of each department a statement of the unexpended balance of the appropriation or bonds set aside for his department."

Article IV, Chapter II, Section 9 (new):

"The Supervisors may by ordinance authorize and provide for the payment through the agency of any regularly licensed bank in the State of California of wages, salaries, or compensation due to any person or persons engaged on public work of the city and county outside of the limits thereof. In such cases, payrolls covering such wages, salaries or compensation must be first approved by the Board or officer in charge of such outside work and forwarded to the Auditor for his audit and approval. After approving the same he shall, if so directed by such ordinance, draw his warrant for the gross amount of said payroll as approved in favor of such bank, and the Treasurer shall upon receipt of such warrant pay the amount thereof over to said bank for distribution to the persons entitled to the same in such manner as may by said ordinance be provided."

Article VI, Chapter I, Section 9, Paragraph 8:

"The Board of Public Works shall have charge, superintendence and control, under such ordinances as may from time to time be adopted by the Supervisors:

Paragraph 8. "Of the construction, maintenance and operation of any and all public utilities, owned, controlled or operated by the City and County, or which may hereafter be so constructed, owned, controlled or operated. Full authority is vested in the Board of Public Works to carry out the powers granted in this paragraph, and it may, in accordance with such ordinance as the Supervisors may enact, contract for work to be performed, or materials or equipment to be furnished, or for expert, technical or professional services to be rendered, wherever such work, services, materials or equipment are certified by the City Engineer to be necessary in connection with the construction, maintenance or operation of such utilities."

Article XII, Section 10b (new):

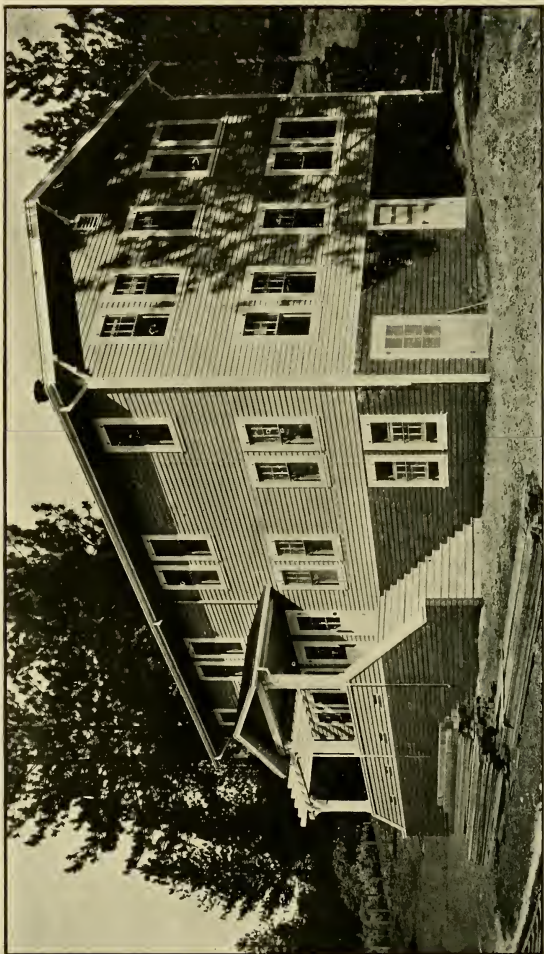
"The Board of Supervisors is hereby authorized to sell bonds of the issue of July 1, 1910, and described as "Water Bonds, Issue of July 1, 1910", below the par value thereof, such price, however, not to be less than that which will net the purchaser five and one-half per cent per annum according to the standard table of bond values."

Amendment 42, Article XII, Section 9:

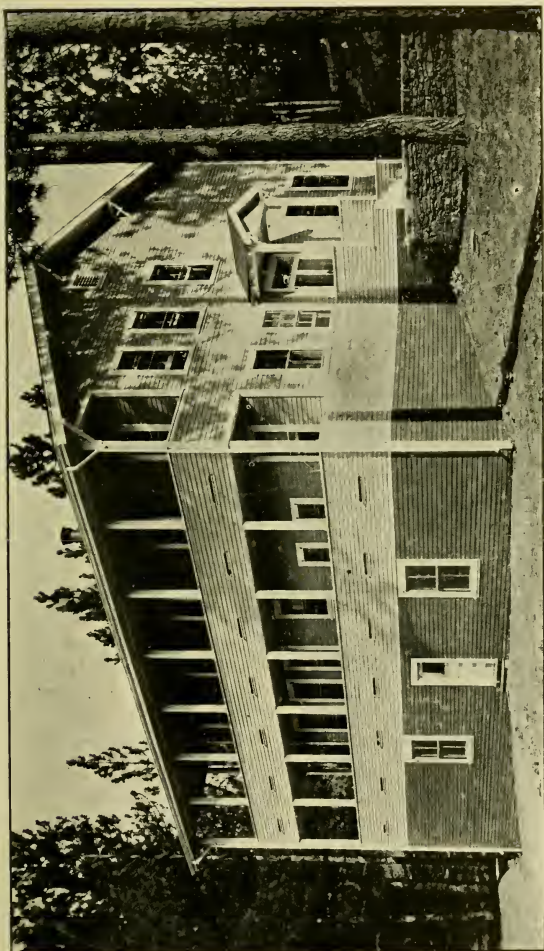
"Except as herein provided, no indebtedness shall be incurred for the acquisition, construction or completion of any public utility or utilities under the provisions of this article, which together with the existing bonded indebtedness of the City and County shall exceed at any one time 10 per cent of the assessed value of all real and personal property in the City and County, provided, however, that any bonded indebtedness that may have been heretofore or that may be hereafter incurred for the acquisition, construction or completion of any earning public utility or utilities, shall be exclusive of the bonded indebtedness of the City and County limited by this section. Street railways, water works, and works for the generation, transmission and distribution of electric current for operating and lighting purposes, are hereby declared to be earning public utilities."

The amendment to Article III, Chapter I, Section 10, would enable the Board of Public Works to enter contracts, with the understanding that the contractor, or his financiers, would purchase, at par, sufficient bonds to pay for the work contemplated under any contract.

Article IV, Chapter II, Section 9, is necessary in order that the efficient method of handling payrolls,



City Employees Quarters—Groveland



City Hospital—Groveland

introduced by the City Engineer during the past fiscal year, may be improved, and enable employees in Tuolumne County to receive their pay more promptly. At present, payrolls are handled through the courtesy of the First National Bank of Sonora, which advances money to pay off employees who leave the work before the monthly payroll is certified by the City Auditor. At the end of each month, demand is drawn on the City Treasury for salaries of all Hetch Hetchy employees. Separate checks for each employee are made out by the Board of Public Works, forwarded to the Auditor, and later delivered to the Bank of Sonora. Much clerical work could be avoided and more prompt payment assured under the provisions of the new section named.

The amendment to Article VI, Chapter I, Section 9, Paragraph 8, more specifically defines the authority which must be vested in the Board of Public Works, in order to insure the efficient construction of this project. On this question, the Charter has been interpreted differently by different Judges of the Superior Court, and it is essential that the powers of the Board of Public Works be defined in unmistakable terms.

War conditions have made the amendment to Article XII, Section 10b advisable, as it is impossible in the present state of the bond market to dispose of water bonds at par, in sufficient quantities to enable the work to be carried on on a large enough scale to insure the strictest economy.

The amendment to Article XII, Section 9, would take revenue earning utilities out of the 15 per cent bond limit and reduce the limit for all projects to 10 per cent. It is in line with the policy of cities owning their own utilities throughout the country and would help the credit of San Francisco in Eastern money markets. It would also enable the citizens to put their often declared policy of entire ownership of earning public utilities into shape for practical accomplishment.

Hetch Hetchy Railroad:

During the past fiscal year, the Hetch Hetchy Railroad, although not completed, has been in continuous use. Materials for Lake Eleanor, the Lower Cherry Power Development, and the Aqueduct Tunnels have been hauled over the road at a saving in the cost which was in effect when motor trucks were used for hauling material over the county road.

Due to financial difficulties encountered by the Contractor, who was unable to complete his contract under the provisions of the specifications therefor, a provisional acceptance of the railroad was made, with the understanding that the City would complete it, deducting from the final payment thereon the actual cost of completion. The principal work which the City undertook under this agreement was ballasting the roadbed. This work has been in progress but has not been carried to completion rapidly, due to the difficulty in securing labor, suitable locomotives and rolling stock. The City purchased two Heisler locomotives, not through choice, but of necessity, because suitable direct-connected locomotives could not be procured.

On August 8, 1917, bids were called for furnishing three Mikado type locomotives. Two bids were received, the lowest being that of the American Locomotive Company, in the sum of \$47,500, for each engine, but neither of the bidders would guarantee delivery within ten months, and the price was double the normal price previously prevailing.

The locomotives which were required under these specifications were 90-ton Mikados, with cylinders 20 inches by 28 inches; drivers, 48 inches, steam pressure, 180 pounds; and tractive effort, 35,700 pounds.

Unable to secure such engines, specifications were prepared for furnishing geared locomotives, new or second-hand. Only one suitable proposal was received, that of Zimmer-Wells-Brown Company, which offered one

57-ton Heisler, second-hand, in first-class condition, at a cost of \$15,973. This engine was purchased, and the City Engineer purchased in the open market one 75-ton Heisler locomotive, new, from the Heisler Locomotive Works, at a cost of \$24,100.

As was expected when this type of equipment was purchased, there has been considerable expense in the maintenance of these geared locomotives, which it is the intention of the City Engineer to replace with direct-connected engines as soon as it is possible to secure the same. The geared engines can then be sold, probably at a material advance over the price paid therefor.

Six box cars were purchased at a cost of \$550 each from M. F. Brady & Son, and three were purchased at a total cost of \$2250 from Willett and Burr; four ballast cars were purchased at a cost of \$950 each from the Western Wheeled Scraper Company, and seven flat cars and eight ballast cars were purchased from F. Rolandi, at a total cost of \$9500. The box cars are used in hauling freight on the Hetch Hetchy Railroad and the ballast cars for completing ballasting operations on the road.

At the end of the fiscal year, the railroad was ballasted from Hetch Hetchy ^{Junction} to Cavagnaro Siding, with some intermediate stretches between Cavagnaro Siding and Groveland also completed.

At the beginning of the past fiscal year, the amount that had been expended on the railroad was \$1,437,411.33. During the past fiscal year, the track laying was completed to Hetch Hetchy Damsite, and the total estimated amount due the contractor was \$1,612,178.86.

The following is an itemized account of the work performed by the Contractor:

Grading, Excavation	1,161,997.2	Cu. yds.	.67	\$ 778,538.12
Overhaul	476,542	Sta. yds.	.01	4,765.42
Culverts, 12"	3,249	Lin. ft.	.90	2,924.10
24"	11,892	Lin. ft.	1.75	20,811.00
30"	1,306	Lin. ft.	2.50	3,265.00
36"	2,106	Lin. ft.	3.15	6,633.90
Fencing, Common	6.291	Miles	600.00	3,774.60
Hog-Tight	31.801	Miles	670.00	21,306.67

Ballast:

Sec. 4 Gravel (40% complete)	1.042	Miles	562.08	585.69
Sec. 5 Gravel.....	13.165	Miles	1,503.65	19,795.55
Sec. 5 Gravel.....	1000.	Cu. yds.	.85	850.00

Track Construction:

Track Laid	70.130	Miles	8,450.00	592,598.50
Switch Sets	27	Sets	140.00	3,780.00
Guard Rails	2824.2	Lin. ft.	.62	1,751.00
Point Castings	780	Pounds	.065	50.70
Rail Braces	2702	Pcs.	.33	891.66
Anti-Creepers	1665	Pcs.	.21	349.65
Derails	5	Pcs.	15.00	75.00
Cattle Guards	60	Pcs.	15.00	1,200.00
Redwood Water Tanks.....	6	Pcs.	400.00	2,400.00

Tuolumne River Bridge:

Truss	487,121	Pounds	.053	25,817.41
Girders	73,562	Pounds	.052	3,825.22
Trestles, Lumber, Erect.....	670,592	Ft. MBM	40.00	26,823.68
Iron in Trestles.....	42,694.87	Pounds	.05	2,134.74
Masonry, Concrete	1,492,512	Cu. yds.	12.00	17,910.14
Dry Rubble	134.9	Sq. yds.	2.00	269.80
Telephone Line Complete.....	50.363	Miles	575.00	28,958.73
On poles already set.....	7.878	Miles	380.00	2,993.64
Station Instruments Installed..	10	Sets	16.00	160.00

Extra Work:

At Station 2924-50, driving 7-ft. Tunnel, 130 ft. @ \$13.00 per ft...\$	1,690.00
Excavating Portals—235 cu. yds. @ \$1.50.....	352.50
Force Account Bills No. 1 to No. 266, pertaining to railroad work only.....	34,896.44

\$1,612,178.86

This amount does not include \$190,630.93 paid in 1915 for grading 9 miles of roadbed from Hog Ranch to Hetch Hetchy.

To maintain locomotives and equipment on the Hetch Hetchy Railroad, a shop building was designed to be located near the City's office headquarters at Groveland. The following equipment was ordered under contract for the shops: Two engine lathes, with all necessary fittings; one shaper; one heavy-duty radial drill, with 3-foot radius. Lathes, shaper and drill are each operated by independent motors. The machine shop is also equipped with pipe and bolt threading machine; double emery wheel grinder; power hack saw, all driven with independent motors, shafting and pulleys. The black-



Hatch Hetchy Transmission Line

smith shop is equipped with motor-driven power hammer and two forges, with independent motor-driven blowers.

The Hetch Hetchy Railroad is now operated as a common carrier but is not subject to the jurisdiction of the Interstate Commerce Commission, since no interstate passenger tickets are sold by its agents, nor freight for direct shipment made to points outside the State; freight shipped from outside of California for use on the City construction work is billed to Hetch Hetchy Junction, on the Sierra Railway, and forwarded to destination from the Junction.

The City will derive a considerable revenue from handling shipments of freight originating along the line of the Hetch Hetchy Railroad. Already a mill is being constructed on the Middle Fork of the Tuolumne, near Hog Ranch, by the California Peach Growers' Association, from which probably five carloads of lumber daily will be furnished for shipment from Hog Ranch to Hetch Hetchy Junction, a distance of 59 miles.

The following passenger and freight tariffs have been filed with the Railroad Commission of the State of California, and are now in effect:

LOCAL PASSENGER TARIFF NO. 1

Section 1. Stations between which this tariff applies:

Big Creek	Groveland	Priest Portal
Big Oak Flat	Hetch Hetchy Junction	Ranger
Buck Meadows	Hog Ranch	Rattlesnake Creek
Canyon Ranch	Intake	Red Hill
Cavagnaro	Jones	Sixbit Gulch
Damsite	Munn	Smith
		South Fork

Section 2. Rules and regulations governing this tariff:

1. Fares shown herein are adult fares, are in dollars and cents, and are payable in United States gold coin, or the equivalent thereof.

2. Sale of Continuous Trip Tickets: When passengers ask for a ticket without specifying a desire to stop over, they should be sold continuous trip tickets.

3. Limits: Tickets sold at fares herein quoted in Section 3, will be limited to the day following date of sale. Tickets sold at fares made in accordance with basis shown in Section 5 will be limited to six months from date of sale.

4. Stopovers: Stopovers will not be allowed on tickets sold at fares shown in Section 3, but continuous passage commencing on date of sale or date following date of sale will be required.

Stopovers will be allowed within limits on tickets sold at fares made in accordance with instruction shown in Section 5.

5. Children's Fares: (a) For children 5 years and over, but under 12 years of age, fare will be one-half the fare shown in this Tariff, adding sufficient when necessary to make the fare end in "0" or "5".

(b) The minimum fare for a child's ticket will be 10 cents for a limited ticket and 25 cents for a six-months' ticket.

(c) Children under 5 years of age, free, when accompanied by parent or guardian.

6. Prohibited Sales: Tickets must not be sold to a station herein for a particular train when such train is scheduled not to stop at such station, nor for trains that do not carry passengers.

7. Redemption of Tickets: Tickets of this Company's issue will be redeemed to the original purchaser at fare paid when no portion of the trip has been made, and at the difference between fare paid and the published tariff fare between points used if trip was discontinued and not completed, but if baggage was checked and no portion of trip made by passenger, redemption will be made at the difference between fare paid and the charge for 150 pounds of excess baggage.

8. Tickets Non-Transferable: Tickets are non-transferable and if found in the hands of any other than the original purchaser will be lifted and full fare collected.

Section 4. Train Fares:

Ten cents in addition to above fares must be collected when passengers fail to purchase tickets before boarding trains, except from stations where there is no ticket office, or when ticket office is closed at or just prior to departure of train, or when there is an unusual crowd at ticket window, or when for any reason agent has not given passenger an opportunity to purchase a ticket.

SECTION 3 PASSENGER FARES

[illegible]

COST IN DOLLARS PER TON OF 2000 POUNDS, IN CARLOAD LOTS

	Hetch Hetchy Junction	Sixbit Gulch	Munn	Cavagnaro	Rattlesnake Creek	Priest Portal	Big Oak Flat	Groveland	Big Creek	Smith	Ranger	Buck Meadows	South Fork	Red Hill	Jones	Intake	Hog Ranch	Canyon Ranch	Dam Site
Hetch Hetchy Junction	.90																		
Sixbit Gulch																			
Munn	1.40	.50																	
Cavagnaro	2.15	1.25	.75																
Rattlesnake Creek	2.65	1.75	1.25	.50															
Priest Portal	2.90	2.00	1.50	.75	.25														
Big Oak Flat	3.15	2.25	1.75	1.00	.50	.25													
Groveland	3.40	2.50	2.00	1.25	.75	.50	.25												
Big Creek	4.15	3.25	2.75	2.00	1.50	1.25	1.00	.75											
Smith	4.40	3.50	3.00	2.25	1.75	1.50	1.25	1.00	.25										
Ranger	4.65	3.75	3.25	2.50	2.00	1.75	1.50	1.25	.50	.25									
Buck Meadows	4.90	4.00	3.50	2.75	2.25	2.00	1.75	1.50	.75	.50	.25								
South Fork	5.50	4.65	4.15	3.40	2.80	2.65	2.40	2.15	1.40	1.15	.90	.65							
Red Hill	5.75	4.90	4.40	3.65	3.15	2.90	2.65	2.40	1.65	1.40	1.15	.90	.25						
Jones	6.25	5.40	4.90	4.15	3.65	3.40	3.15	2.90	2.15	1.90	1.65	1.40	.75	.50					
Intake	6.40	5.50	5.00	4.25	3.75	3.50	3.25	3.00	2.25	2.00	1.75	1.50	.90	.65	.15				
Hog Ranch	7.40	6.50	6.00	5.25	4.75	4.50	4.25	4.00	3.25	3.00	2.75	2.50	1.90	1.65	1.15	1.00			
Canyon Ranch	7.90	7.00	6.50	5.75	5.25	5.00	4.75	4.50	3.75	3.50	3.25	3.00	2.40	2.15	1.65	1.50	.50		
Dam Site	8.50	7.65	7.15	6.40	5.90	5.65	5.40	5.15	4.40	4.15	3.90	3.65	3.00	2.75	2.25	2.15	1.15	.65	

LOCAL FREIGHT TARIFF NO. 2

Section 1. Stations Between Which Tariff Applies:

Big Creek	Groveland	Priest Portal
Big Oak Flat	Hetch Hetchy Junction	Ranger
Buck Meadows	Hog Ranch	Rattlesnake Creek
Canyon Ranch	Intake	Red Hill
Cavagnaro	Jones	Sixbit Gulch
Damsite	Munn	Smith
		South Fork

Section 2.

Minimum charge for any single less than carload shipment will be 25 cents.

Section 3.

Freight must be prepaid to non-agency stations, and will be delivered to non-agency stations only at owner's risk.

Section 4. Oils, peroleum or petroleum products, viz:

Petroleum crude oil,

Petroleum road oil,

Petroleum fuel oil, viz. refinery residuum in packages.

Minimum carload weight, 30,000 pounds.

—or—

In tank cars, weight per gallon $7\frac{3}{4}$ pounds, based on the full capacity of the tank, unless the weight carrying capacity of the car trucks is less, in which case the actual weight subject to the weight carrying capacity of the car trucks will govern as minimum.

Lower Cherry Power Development:

The Lower Cherry power house, to furnish electricity for construction purposes over the entire Mountain Division, was completed during the past fiscal year. The structure, being intended for temporary purposes only, is of simple wood frame construction, covered with asbestos protected metal. The foundations are of massive concrete, necessary to resist floods. The machinery and equipment are of the most modern type and design, consisting of three Francis Pelton turbines, each designed to operate at 720 revolutions per minute and to develop 1500 horsepower. Each is direct-connected to a 2300-volt, 3-phase, 60-cycle generator of



Tramway from Hetch Hetchy Railroad to Early Intake Tunnel Portal

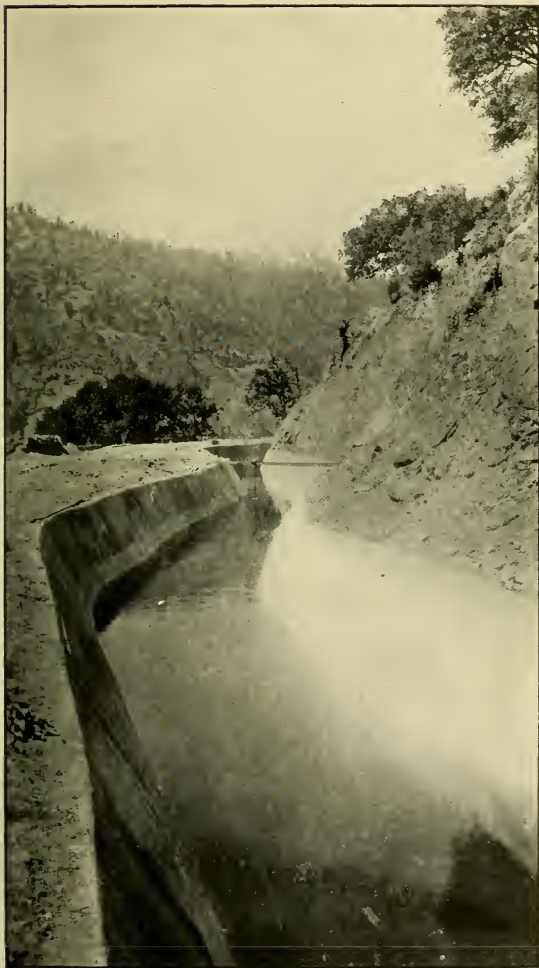
1,000 KYA capacity Transformers at the power house step up the current from a voltage of 2300 to 22,000 for transmission to the work.

Water for the operation of the power house is diverted from Cherry River and carried through a conduit, consisting of $1\frac{1}{2}$ miles of flume, one mile of concrete-lined open canal, and 5 tunnels, $7\frac{1}{2}$ feet square, aggregating one mile in length. The tunnels are in granite formation and are unlined, except at the portals and at a few points where loose rock was encountered.

Concrete for the canals was poured from a 2-sack batch mixer, mounted on an improvised traveler, which spanned the canal. Alternate slabs on the side walls were poured in 8-foot lengths and spaced with expansion joints of heavy roofing paper. This operation required the traveler to move forward about 200 feet and then return for pouring the alternate slabs. The bottom was poured last. A rock crusher was erected adjacent to the canal, at a central point on the work, and crushed material from one of the tunnel dumps.

Flumes were built on very precipitous slopes, where the cost of excavation for concrete canal would have been prohibitive. With more abundant labor and supplies, it is contemplated in the future to substitute tunnels for these flumes and the necessary crosscuts for this purpose have been completed so that work can be prosecuted without interrupting the use of the plant. Excavation for the footings was carried to solid rock, the lower framing completed, and the floor laid. On the finished floor, a wooden rail track was laid, and push cars used to convey lumber for the sides. In all, 1,300,000 board feet of lumber was used, all of which was manufactured at the City's sawmill, and transported by train and auto truck to the canal line.

The power house was first tested in operation on May 6, 1918. Since that date the plant has been run continuously to supply power to the various tunnel working



Concrete Lined Canal
Lower Cherry River Power Development

faces and shaft camps. It is estimated that the sale of surplus power from this plant in the immediate future will bring into the City treasury a net revenue of \$9,000 per month.

The entire Lower Cherry power development was constructed by day labor, under the direction of the City Engineer.

The transmission line from Early Intake power house to Priest reservoir was likewise constructed by day labor. A right of way 100 feet in width, vertically over the line of the tunnel aqueduct, was first cleared of timber; and cedar poles, cut in Tuolumne County, erected thereon during the winter of 1916-1917. These poles, as far as possible, were cut close to the transmission right of way. On straight line runs, the poles are spaced approximately 225 feet apart.

Substations were erected at each point where electricity would be required for construction purposes. These substations are provided with transformers, primary and secondary, high and low tension switches, lightning arresters and meters.

Lake Eleanor Dam:

To provide, during low water periods, adequate storage for the continuous operation of the Lower Cherry power plant above described, it was necessary to create a reservoir at Lake Eleanor. An excellent site existed there, a portion of which was already occupied by the lake, which is $1\frac{1}{2}$ miles long and $\frac{3}{4}$ -mile wide.

About a mile below the lake was a favorable bed rock site for a concrete dam. Solid granite bedrock exists at the surface throughout, and a structure several hundred feet in height can eventually be built on this site, in which case the preliminary concrete dam, just finished, would probably be incorporated into it and used as the up-stream toe for the future structure. Large deposits of sand and gravel were contiguous to the damsite.

Speed of construction with minimum transport of material were absolutely essential to impound sufficient water to operate the power plant during the dry season of 1918. These considerations rendered advisable the choice of a dam of the buttressed multiple arch type. A record for rapid construction was established in erecting this structure.

A preliminary examination of the site was made by the City Engineer on July 20, 1917. Topographical surveys were started within a few days thereafter. To render the site accessible for hauling construction materials, a wagon road, 14 miles in length was constructed, extending to the Lake Eleanor damsite from the terminus of the Hetch Hetchy Railroad at Hetch Hetchy Valley. This road is built largely in solid granite and ascends 1800 feet above the floor of the valley, in a distance of $3\frac{1}{2}$ miles, on an almost continuous $12\frac{1}{2}$ per cent grade. Due to the precipitous nature of the country, considerable care was necessary in the location of this road. There are 13 switchback turns, most of which require several reversals of an auto truck, on the curves.

It was necessary to cross the Tuolumne River above the Hetch Hetchy damsite with a highway truss structure, 168 feet in span, on pile abutments, and approached by pile trestle work construction. The bridge is 50 feet above the stream bed.

Grading on the Lake Eleanor road was completed on September 14, 1917, and auto trucks immediately started hauling cement thereover for Lake Eleanor dam.

At the same time that construction work on the road was in progress, a small sawmill was started near Eleanor damsite, to provide timber for form work, camp buildings, etc. The mill was erected $\frac{1}{2}$ -mile above the damsite on Eleanor Creek, in a location from which lumber could readily be hauled to the dam. Surrounding the mill was a large body of timber, from which a selection of logs was made to meet the requirements. Erec-

tion of the mill was started on August 1, 1917, and it was placed in operation on August 29, 1917. During the six months the mill was in operation, approximately 900,000 board feet of lumber was manufactured and used in the construction of the dam and its appurtenances.

Excavation of the dam foundation was commenced on September 1, 1917, and continued to completion with the use of hand derricks. All excavation work was carried to a depth of several feet below any seams in the granite formation. Foundations for arches and buttresses vary from 5 to 15 feet in depth below the surface.

Form work was carried on closely behind the excavation and concrete pouring in the footings was started on November 4, 1917. The endeavor was to get concrete poured in sufficient height before heavy snowfall to enable construction to proceed in the following spring without interference from the anticipated flood waters. Concrete pouring was continued until December 22, 1917, and six temporary four feet by two and one-half feet openings left in the face of the dam through which floods could pass. A considerable amount of cement was stored at the damsite during the winter, in anticipation of bad transportation conditions over the new road during the thawing period. From December 22, 1917, until April 22, 1918, no work was done on the structure.

Sawmill operations were resumed on April 22, 1918, and concrete pouring was resumed on May 11, 1918.

A fleet of 12 auto trucks was used for hauling cement from the railroad to the dam, working two or three shifts, as the demand required.

For the concrete, samples were taken of gravel deposits in the vicinity, and pits selected to give the proper grading of the aggregate, based on laboratory tests. Traps, of sufficient height to permit of installation of screens and the loading of trucks by gravity, were built at the pits. Four-horse Fresno scrapers were used for placing the gravel on the traps and a proper propor-

tion of sand and gravel was delivered to large bunkers, slightly above the crest of the dam. Under the sand and gravel bunkers, narrow gauge side dump cars were operated by gravity to the mixer, which was located on the crest of the dam. A one-yard Foote mixer was used, from which one-yard bottom dump cars were handled by endless cable, operated by single-drum steam hoisting engine. With this engine, cars were placed at exact positions over the various chutes along the work.

The arch forms were carried up in sections of about 10 feet in height and supported on the trestle work, which was built in a very substantial manner. Trestle work was raised in bents, 20 feet in height, as the work progressed, to a point 8 feet above the floor slab.

The plant used required a very small investment and proved very efficient. The capacity for an 8-hour shift, including shut-downs, was about 100 cubic yards, and a maximum pour of 130 cubic yards was made.

The completed structure, which is finished with a $\frac{3}{4}$ -inch coat of grout, is 1260 feet in length and 70 feet in height above the stream bed. It required 11,640 cubic yards of concrete and 262,000 pounds of reinforcing steel. There are 20 arches of 40 feet span, supported on buttresses, and 460 feet of gravity wall. Of this wall, 200 feet is used as a spillway, with removable flash boards. A log chute is also provided in this section.

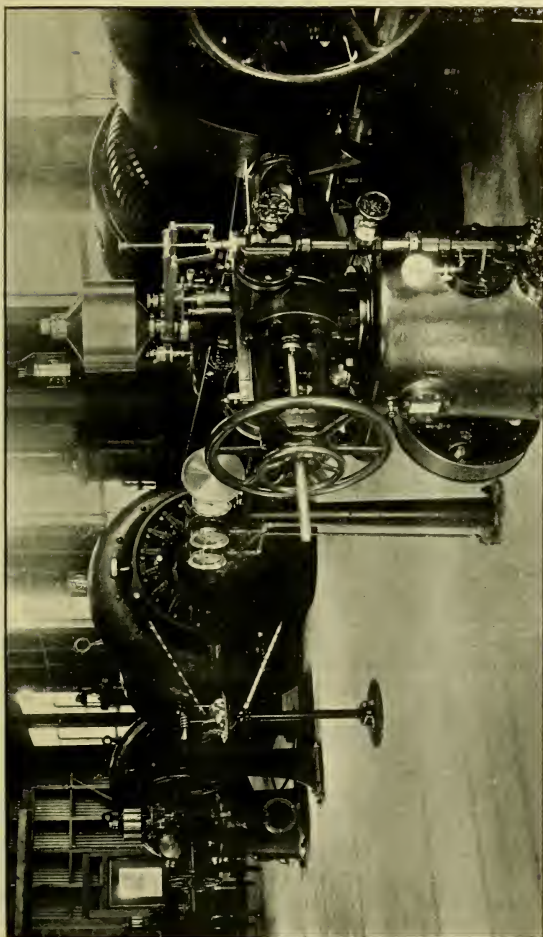
Over the entire length of the dam is a reinforced concrete slab roadway, with galvanized iron railing.

This dam creates a reservoir, when full, of 25,000 acre-feet, which is withdrawn through two 24-inch sluice valves, placed on the face of the dam. In addition, two 24-inch scouring valves are placed at the bottom of the dam.

All work in connection with this structure was done by day labor.



Early Intake Power House—Exterior



Early Intake Power House—Interior

Sawmill Operation:

At a point on the Hetch Hetchy Railroad, 6 miles west of Hetch Hetchy Dam, Canyon Ranch Sawmill is located. This is a double circular saw plant of 20,000 F. B. M. capacity, in connection with which a planing mill is operated. The mill is located on City property, consisting of 640 acres of timber land, covered with sugar pine, yellow pine and red fir.

All lumber and timber used in connection with the project is manufactured at the City plant and transported by railroad as back haul to the various jobs.

Logging operations are handled with two Washington Bull Donkeys, covering a radius of 4,000 feet.

During the year 1917-1918, 1,700,000 F. B. M. of lumber was manufactured and 430,000 B. M. surfaced.

This lumber represents a cost, including amortization charge on the plant, of about \$11.50 per 1000 feet B. M. in the yard.

Tunnel Aqueduct:

The tunnel aqueduct, from Early Intake, which is on the Main Tuolumne River about 12 miles below Hetch Hetchy Dam, to Priest Regulating Reservoir, is 18.3 miles in length.

Bids were solicited on this work and examined on August 22, 1917. Owing to the high prices asked by the contractors, all bids were rejected and the work undertaken by day labor.

Prior to asking for bids, wagon roads of very heavy construction were built, adits opened up and core borings taken over the entire distance.

The work lies in a very mountainous country, but with the Hetch Hetchy Railroad paralleling and touching practically every portal, with the use of short wagon hauls, it is made very accessible.

On reaching the decision to drive this tunnel by day labor, contracts were let for machinery to handle the

work from four portals and two shafts. This machinery consists of 8 Laidlaw feather valve compressors of 680 cubic feet capacity, driven by 100-horsepower alternating current, squirrel cage, induction type 440-volt motors—belt driven types were selected as being more salable on completion of the work; six 24-inch gage electric storage battery locomotives, with charging equipment and accessories; 45 steel body, side-dump, roller-bearing tunnel cars, and 30,000 lineal feet of 30-pound track steel, with fastenings, switches, etc. Two double-drum hoists, driven with reversible 150-horsepower motors were secured for hoisting at the shafts.

In addition to the above equipment, air-driven drill sharpeners and latest type of Ingersoll-Water-Leyner, Sullivan and Waugh drills have been secured, and tests are being made as to the relative efficiency of the different types in the rock encountered.

The general idea in selecting machinery has been to have standard equipment at all camps and to carry a good stock of spare parts and extra equipment for replacements.

Camps for housing and feeding the men have been built and machinery installed at four portals.

In opening up this work, the longest units were attacked first, the Early Intake tunnel being $4\frac{1}{2}$ miles in length, and the Priest tunnel, 4 miles in length. On the former tunnel, which is in solid gray granite of extreme hardness, an arch section with straight walls has been adopted, as this affords better working conditions and is permissible because the tunnel here is subject to very little external pressures. On the western section of Priest tunnel, a horseshoe section is better adapted to the more broken formation.

All tunnels are being pulled to full section, using rounds of from 18 to 24 holes. Two machine drills are mounted on cross-bars and are able to put in a 5-foot round per shift. Steel muck sheets, fitting snugly in the

bottom of the tunnel, have been found to greatly facilitate the hand mucking operation. Due to extreme hardness of all rock encountered, 60 per cent and 80 per cent powder is used.

A very small portion of the tunnel requires timbering to hold the formation, but it is intended to place a 6-inch concrete lining throughout its length for increasing the discharge capacity.

For driving tunnel, exclusive of timbering and concreting, this work is costing from \$20 to \$32 per lineal foot, depending upon the character of the rock.

In connection with the method by which the aqueduct tunnels are being driven, the following transcript in response to certain criticism is of interest:

In response to resolution passed by the Board of Supervisors March 4, 1918, making inquiry as to the procedure under which the Hetch Hetchy work was being prosecuted, the following reasons were submitted to the Board and after a discussion, received its unanimous approval:

CITY ENGINEER'S OFFICE

March 8, 1918.

To the Honorable, The Public Utilities Committee of the
Board of Supervisors, City Hall, San Francisco.

Gentlemen:

I have at hand the following Resolution of the Board of Supervisors:

"Whereas, The Board of Public Works has requested an appropriation of \$250,000 for the prosecution of the work on the Hetch Hetchy Water Supply, and

"Whereas, This money is to be expended in payment of non-contract work, and

"Whereas, It is very advisable for the Board of Supervisors to know the approximate cost of the construction of the Hetch Hetchy Water Supply, if we are to proceed very far under the non-contract plan; therefore be it

"Resolved, That the Board of Public Works be and is hereby requested to furnish this Board with an estimate of the cost of constructing the Hetch Hetchy Water System if they are obliged

to construct said system under the non-contract or day labor plan."

In reply, I submit the following:

In such times as the present, with an extraordinary national emergency confronting us, and with the Nation demanding, for the successful prosecution of the war, the best efforts of all its citizens in whatever line of endeavor they may be able to assist in this great cause, the upsetting of the ordinary routine of work and progress in all industries necessarily results in such disturbed conditions that it becomes impossible to make any definite cost estimates for the immediate future of any enterprises not directly connected with the war.

Just as prices of household supplies have gone up in a manner unprecedented in years of peace, so the enormous demand for materials of construction and for labor to incorporate those materials into structures has resulted in higher prices of both labor and materials, and where large quantities of either are required, it is in some cases impossible to secure them.

After the passing of the emergency, prices will gradually be brought back to a normal basis, which may or may not be the same basis as prevailed before the entry of our own country into the war or the beginning of the war in Europe.

No one may guess what will be the price of beef or flour a year hence in your homes, and no more can the Engineer guess (for estimating is not the word to use under the present circumstances) what will be the prices of steel or cement or labor a year from now.

You can readily see therefore that it would be useless for me to attempt to give any figures which could pretend to accuracy, as to the cost of such a project as the Hetch Hetchy Water System, if construction work on the project as a whole were to be forced ahead under the unsettled conditions of the present and the near future.

The question of the estimated cost of this project came up recently in an inquiry made by the Civic League of Improvement Clubs and Associations of San Francisco, a body of public spirited citizens, who, becoming desirous of knowing the exact status of the Hetch Hetchy Water Supply work, appointed a Committee to visit the City Engineer for a consultation. This Committee rendered a report, dated February 7, 1918, and signed by George Skaller, as Chairman of the Committee. This report has been presented to your Committee and to the Board of Supervisors as a whole. My opinion as to the cost of the project is set forth in the report in two paragraphs, and in response to your present query, I think I cannot do better than to quote the same:

"With reference to the cost of construction of the entire project, Mr. O'Shaughnessy informed the Committee that the present bond issue of \$45,000,000 will take care of the entire construction, bringing the waters to the County line of San Francisco, providing the cost of material will gradually be restored to the basis of prices existing in the early part of 1916, when his estimate first was prepared.

"The cost of material is almost 50 per cent of the project; should, contrary to expectations, cost of material not return to a normal basis after the war, and present prices of materials, which have advanced about 50 per cent average, maintain themselves, the cost of the project would increase from ten to twelve millions of dollars."

So much for the matter of the total cost. From the form of the resolution already quoted, however, I take it that the Board of Supervisors is really more concerned to know how the cost of work on the Hetch Hetchy Water Supply, if executed on a day labor basis, will compare with the cost on a contract basis. The question might better be, "Considering the times, is contract work possible?"

On August 22, 1917, the Board of Public Works received bids for the construction of the tunnels of the Mountain Division of the Hetch Hetchy Aqueduct. Only one bid for the whole of the proposed work was received—that of R. C. Storrie and Company, who constructed the Twin Peaks Tunnel by contract. The amount of this bid was \$9,233,671. The City Engineer's estimate of the cost of the work on the contract basis was \$6,200,000, the Contractor's figure being about 50 per cent in excess of the Engineer's estimate. This great discrepancy is explained by two principal considerations: first, due to the fact that the City had been unable to dispose of bonds in an amount sufficient to cover the contract price, the Contractor figured on marketing the bonds through his own financial connections, and included in his bid an amount sufficient to make up for the discount of the City's bonds and the other expenses of disposing of these bonds; second, the Contractor expected a heavy rise in the price of labor and materials of construction. The City Engineer in preparing his estimate, of course, made allowance for probable increased prices, but evidently it was the Contractor's opinion that such prices might rise much more than the Engineer expected.

Now, a Contractor is in business to make money, and when bidding on a very large piece of work, he wants to be very sure that he is going to come out with a profit, or at least that he is not going to lose; hence in times of violent fluctuation of prices, the contractor must include in his bid a heavy percentage merely to insure himself against greatly increased prices. If prices do not

go up to the maximum figures which he considered possible or probable, or if they fall, he is to that extent the gainer. On the other hand, if the City undertakes the same work, it pays the prices current as the work progresses, and any drop in prices inures directly to the benefit of the City. Furthermore, the Charter of the City of San Francisco provides that before entering into a contract, the City must have on hand in the Treasurer's office the full amount of money necessary to carry out the entire contract, even though the work will continue through several years. This provision alone would have caused the rejection of the bids for tunnel construction, unless the work had been financed through the Contractor; but with the City doing its own work, the money on hand on which interest is being paid need not exceed by more than a reasonable margin the amount necessary to meet the monthly payrolls and material bills.

There are certain features in which the contract plan is more advantageous and there are others in which day labor is preferable, generally speaking, but at present the extravagantly high bids and difficult financing, caused by war conditions, threw the balance far to the day labor side.

By way of showing that the City Engineer's estimate of cost of the Aqueduct Tunnel above referred to was reasonable, and was not a gross underestimate as some of the contractors would have you believe, I will remark that the cost of the work now actually being done on a day labor basis at two portals of that tunnel is less than the cost of the corresponding items in the Engineer's estimate. I will also call attention to the fact that a tunnel, with concrete lining, 8 feet in diameter, is now being built for the Marin Municipal Water District, at a contract price of \$29.70 per lineal foot. The proposed Hetch Hetchy Tunnel is to be 10 feet 3 inches in diameter, inside of the concrete lining, and the estimated cost was about \$60 per lineal foot. The Contractor's bid on the latter tunnel averages about \$90 per lineal foot.

It is instructive to consider the experience of Los Angeles with day labor construction on that City's Owens River Aqueduct, completed a few years ago. This Aqueduct is 215.54 miles in length, exclusive of the length of reservoirs and power conduits—about 40 per cent longer than the Hetch Hetchy Aqueduct. The work was mostly through desert country and required costly preliminary work. The great advantages of day labor over contract work in this case lay in the fact that by judiciously timing the sequence of operations on the various divisions, the equipment and the organization could be transferred from one division to another, as fast as work was completed in the former division, thus avoiding the duplication which would have been necessary if many different

contractors had been working along the line; or, in other words, it enabled the City to coordinate its resources to the best advantage of the work. Several times during the execution of the Aqueduct construction, financial difficulties were experienced, and under the day labor system it was possible to increase or curtail activities according to the funds in hand, whereas if this had been done while there were a number of contractors engaged, endless friction and litigation would have resulted.

The following is a quotation from the Final Report on the Construction of the Los Angeles Aqueduct (page 259) published by the Department of Public Service of the City of Los Angeles, 1916. The quotation sets forth the opinion of the Chief Engineer of the Los Angeles Aqueduct as to day labor work:

"The only portion of the Los Angeles Aqueduct built by contract consisted of 11 miles of canal and 1,485 feet of tunnel between Fairmont reservoir and the south end of the Antelope Valley siphon. This contract was awarded to P. A. Howard, December 12, 1908. The City supplied all cement at the railroad station, lumber and steel, and built main roads, laid the pipe lines and built the telephone line. The contractor furnished all labor, equipment, miscellaneous supplies, such as powder, oil, etc., and the equipment and buildings required for his work.

"Bids were called for in order to compare contractors' figures with the estimates for work to be done by the City, and while it was realized that the prices asked were higher than the work could probably be done for by day labor, it was considered fair on the part of the City to let the contract, after the contractors had gone to the trouble to submit their bids.

"The contract work subsequently cost more than was indicated by the bids, because of certain unavoidable changes that were made in the plans, for which the contractor had to be paid at a price bid per yard for extra concrete. Under the contract, the average cost per foot for the covered Aqueduct was \$14.30. The cost of similar work done by the City's force under conditions where the concrete aggregates, length of haul, etc., were practically the same, was \$10.50 per lineal foot for direct field charges. To this must be added the cost of equipment, buildings and tents, which amounted to 60 cents per lineal foot, making a total cost for work done by the City by day labor of \$11.10 per foot as compared to the cost of \$14.30 per foot paid to the contractor. In other words, the City work cost 78 per cent of the cost of the contract work. The auxiliary charges, which had to be paid by the City, were practically the same in both cases, and the time required for directing the work was greater in the case of the contract job

than where the City superintendent was directly in charge of the work.

"The advantage of doing work by day labor or force account lies particularly in the freedom with which plans can be changed and the line modified to meet conditions as they develop during construction. In addition, when work is being done by day labor, it can be done faster when funds are available, or greatly reduced in case of financial stringency, without damage claims from the contractor. The work done by contract was not more satisfactory than that done by day labor.

"Bids were asked for the building of the Jawbone division by contract, but they were so much in excess of the estimates of the Engineer, even after allowing for 15 per cent profit for the contractor, that they were all rejected, and the work on the Jawbone division was finished for several hundred thousand dollars less than the lowest price bid."

CONTRACT WORK ALREADY EXECUTED ON HETCH HETCHY WATER SUPPLY

To date, 27 contracts for work on the Hetch Hetchy Water Supply have been entered into, aggregating approximately \$2,200,000. Many of these contracts were for machinery and material, but a few, totaling about \$1,900,000 involved large amounts of labor, the largest being the contract for the Hetch Hetchy Railroad.

On work carried out by day labor, we have expended up to date about \$500,000 for wages, a comparatively small percentage of the general total, so it will be seen that it has not been the policy of the City Engineer in the past to commit the City to a day labor basis, but generally, day labor has been resorted to in cases where the contractors' prices were excessive, or where the nature of the work was such that definite specifications and plans would have been very difficult to draw up, and which required constant changes of plan as the work proceeded and new conditions developed. This figure also includes the operation of the City's sawmill and a great deal of pioneer work such as road and trail building, which it would have been impracticable to handle on a contract basis.

Respectfully submitted,

M. M. O'SHAUGHNESSY,

City Engineer.

STATEMENT OF EXPENDITURES ON HETCH HETCHY PROJECT
FROM 1900 TO JULY 1, 1918

Legal Expense, Lands, Rights of Way and Investigations.....	\$1,914,430.99	
Water Rights and Protective Work.....	80,409.83	
Hetch Hetchy Railroad:		
Location Surveys	\$ 7,977.21	
Grading, Hog Ranch to Damsite.....	180,943.84	
Railroad Construction, Hetch Hetchy Junct. to Damsite	1,579,631.30	
Construction by Board of Public Works.....	91,107.31	
Track Ballasting	32,130.39	
		1,891,790.05
Hetch Hetchy Railroad Equipment:		
Two Heisler Locomotives.....	40,637.00	
Machine Shop Equipment.....	1,691.71	
Miscellaneous Equipment and Tools.....	37,659.17	
		79,387.88
Operating Hetch Hetchy Railroad.....		4,172.91
Telephone Lines		4,993.24
Mountain Division Tunnel Aqueduct:		
Three Hydro-Electric Experts.....	5,000.00	
Location Surveys	27,565.93	
Diamond Drill Borings	20,071.68	
Air Compressors	18,106.80	
Motors	7,230.80	
Tunnel Construction	100,741.05	
		178,716.26
Tramway, Early Intake.....		9,670.39
Hetch Hetchy Dam and Reservoir:		
Clearing Portion of Reservoir Site.....	49,362.57	
Diversion Tunnel and Dam Foundation.....	213,575.00	
		262,937.57
Canyon Ranch Sawmill:		
Installing Sawmill	13,000.24	
Timber Cut on Government Land.....	4,125.19	
Sawmill Operation	78,676.90	
		95,802.33
Lower Cherry Power Development:		
Ditch, Tunnels, Flume and Power House Building.....	348,382.92	
Pressure Pipe	7,363.00	
Generators	14,321.00	
Water Wheels	18,838.54	
Station Transformers	7,675.80	
Switchboard	2,849.50	
Clearing and Installing Transmission Line.....	38,349.59	
Line Wire	25,215.87	
Line Insulators and Crossarms.....	3,459.74	
Line Transformers	25,347.00	
		491,802.96
Carried forward		\$5,014,114.41

Forward	\$5,014,114.41
Lake Eleanor Dam	167,599.60
Operating Power House	666.05
Miscellaneous Roads, Trails and Surveys.....	181,816.67
Priest Hill Road	2,500.00
Big Creek Road (Co-operative with Tuolumne County).....	3,500.00
Priest Regulating Reservoir—Clearing and Exploration.....	2,629.00
Hospital Building and Equipment.....	10,131.99
Hospital Maintenance	2,607.00
General Construction Equipment.....	34,511.70
General Camps and Equipment.....	72,527.99
Administration, General Office Work, Plans, etc.....	120,907.34
Inspection and Engineering in the Field.....	104,134.16
*Boarding House	21,628.69
Compensation Insurance	30,765.39
†Revolving Fund	10,000.00
Hydrography	27,056.16
San Francisco Wells	19,906.44
Total.....	\$5,827,002.59

* Portion of this to be returned to City Treasury from deduction from employees.

† Reimbursed as expenditures are made therefrom.

BOULEVARDS AND STREETS

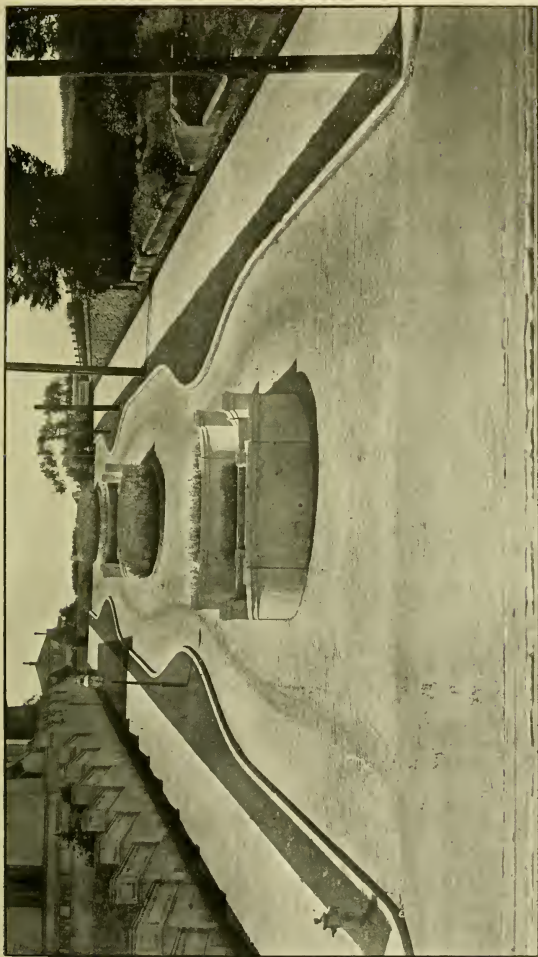
Actuated by a spirit of conservation and to conform to the policy of the Federal authorities, the construction of additional portions of the boulevard system with the exception of very essential units, has been postponed until after the war.

The Bernal Cut, Esplanade and Olympus Boulevard, all of which will be incorporated into the general boulevard system, were not deemed to be absolutely essential to the immediate needs of San Francisco, although it is of great importance to the commercial development of the City that their construction be undertaken as soon as feasible.

However, a thoroughfare which was deemed essential to war industries, not only by the City authorities, but also by Government officials, was the Hunter's Point Boulevard. This roadway affords an excellent avenue for transportation from the Bay Shore Boulevard to the Hunter's Point Dry Dock. The boulevard is almost two miles long and eighty feet in width.

The work was performed under five contracts by H. Crummey, Inc. Section A was located on Evans Ave., from Lane to Ingalls Street; Section B from Evans and Ingalls to Hawes and Hudson to Innes and Hawes; Section C from Hawes and Hudson to Innes and Donahue; Section E on Donahue Street from Innes to Galvez Avenue, and on Galvez Avenue from Donahue to Coleman, and Section F from Galvez and Coleman to Fairfax and Boalt, over a private right of way.

To finance this essential improvement, the City Engineer secured the co-operation of the Bethlehem Steel Company, which contributed the cost of constructing Section B; owners of adjacent property donated the rights of way where these were not already owned by the City. The cost of Section F was defrayed by the City, and the funds necessary to complete all the contracts



Special treatment, brick pavement and parkways Octavia Street, looking south from Jackson Street

except Sections B and F were raised by assessments against the properties fronting on the Boulevard.

Excavation was performed by three steam shovels, most of the material being red rock with serpentine and the balance hard clay. It was necessary to blast the subsoil for practically the entire distance of the roadway. Motor trucks conveyed the surplus material to an adjacent fill or wasted it beyond the limits of the Boulevard. Where the roadway was constructed on fill, this was placed in successive layers one foot in thickness, wet and rolled by a ten-ton road roller.

The maximum fill 20 ft. in depth and containing 6500 cu. yds. was made on Section C. It was deemed advisable to allow this fill to settle completely before the pavement or curb was laid thereon. A temporary strip of the roadway was paved with macadam to meet immediate needs.

For the entire boulevard the excavation amounted to 67,656 cu. yds. and the fill to 48,436 cu. yds.

The pavement on Sections A, D and E consisted of a 6-in. concrete base with a 2-in. sheet asphalt cover. On Sections B and F, it consisted of a 6-in. concrete base with a 2-in. Topeka cover. In all 355,893 sq. ft of standard asphalt pavement, and 125,352 sq. ft. of Topeka were laid.

California granite curbs were set for the total length of the boulevard, and artificial stone sidewalks placed at each intersection, except as above noted and in sections B and F, where a six-foot sidewalk was placed for the entire length of those contracts.

The maximum grade of the boulevard is $9\frac{3}{4}\%$, and in Section B on a 400 ft. radius curve the outer curb and portion of pavement have a superelevation of one foot, which feature, together with the Topeka top, will remove all danger of skidding at any normal speed.

Marina Boulevard:

Another avenue that was considered important from a military standpoint was the Marina Boulevard, 100

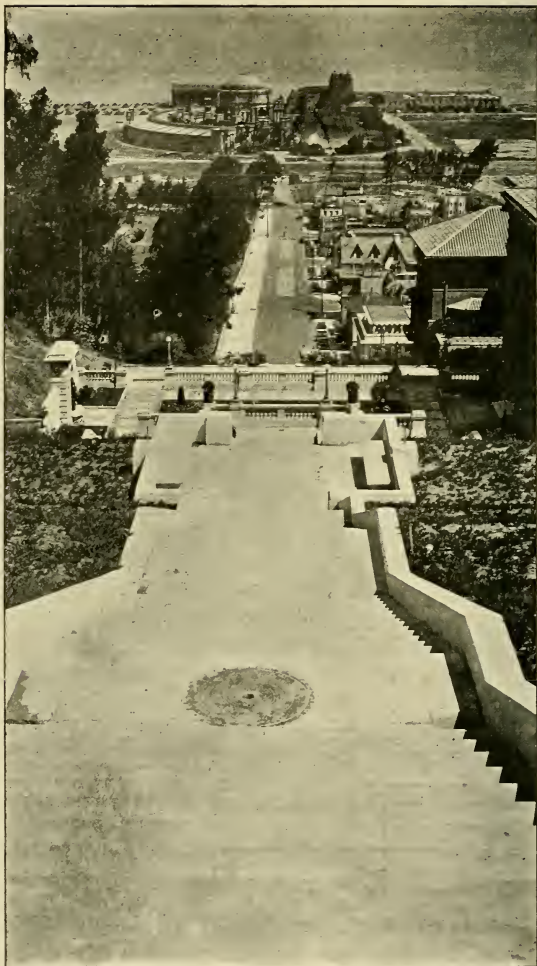
feet wide, which extends from Fort Mason to the Presidio. Accordingly over the fill placed last year from Laguna to Scott Streets, Topeka pavements were laid during the past fiscal year and concrete curbs placed. This work entailed the removal of 3500 yds. of earth, the construction of sewers and appurtenances, 113,000 sq. ft of pavement, 8000 sq. ft. of brick gutters, 4000 lin. ft. of concrete curb and 34,000 sq. ft. of artificial stone sidewalks. The entire cost was \$35,838.54.

Lands held in private ownership and necessary for this improvement, were deeded to the City by the Pacific Gas & Electric Company in consideration of a spur track from the Belt Railroad into the property of that corporation being constructed by the State Harbor Commission at the City's expense.

Widening of Sloat Boulevard—Sloat Boulevard Circle:

During the past twelve months the United Railroads Company has moved its tracks from the northerly line of Sloat Boulevard to the center of the proposed new 135-foot thoroughfare. This improved boulevard will consist of a central strip, 35 ft. in width, for the United Railroad tracks, on both sides of which will be two 30-ft. paved strips, outside of which will lie 5 ft. parking strips, and finally on both sides will be 15-ft. sidewalks. Only that portion of the Boulevard between 19th Avenue and Juniperro Serra Boulevard is to be paved immediately.

Sloat Boulevard Circle on which work will be started shortly, will separate from vehicle traffic the heavy network of tracks at the junction of the Twin Peaks Tunnel Line and the United Railroad's Sloat Boulevard Line. This improvement will be included in the same contract with the widening of Sloat Boulevard. The estimated cost of the improvement exclusive of parking, which will be paid for by interested property owners, will amount to \$25,000.00.



Lyon Street Improvement

Market Street Extension:

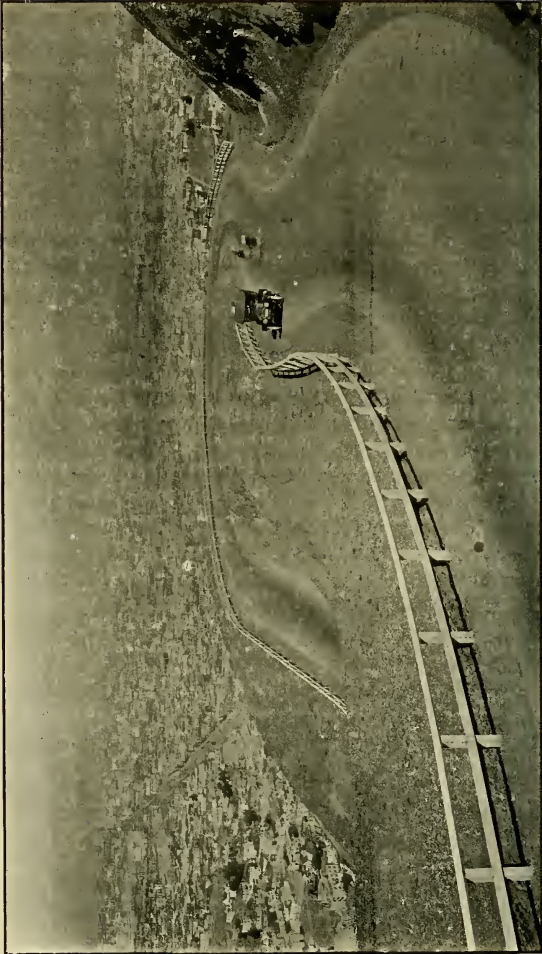
Originally it was intended to construct the Market Street Extension from 17th and Castro Streets to the intersection of 24th Street with Corbett Avenue, the intention being to levy assessments on the district benefited to pay for the improvement.

Until normal conditions again exist, work will be undertaken only on the stretch from Falcon and Caselli Ave. to the southerly terminus of this improvement at 24th Street. The completion of this unit will provide a route for vehicular traffic over the Twin Peaks Ridge, starting at 17th and Castro Streets and extending over 17th Street to Corbett Ave., thence to Caselli Avenue, thence over over the new section contemplated and connecting on the south with Portola Drive.

The length of the section to be built at this time is 3400 ft., and the maximum grade is 8 per cent. The width of the boulevard will be 70 ft. with a 46-ft. roadway and terraced parking strips on either side thereof. The estimated cost is \$160,000, of which \$54,000 will be expended for the acquisition of rights of way, and \$106,000 for actual construction. Property owners are to pay a maximum of \$10 for construction costs a front foot, which will aggregate \$70,000 toward this improvement. The City will bear the expense of the remaining \$90,000.

Worcester Avenue Boulevard:

Economy demands early attention to a shorter route to connect Mission Road with the Junipero Serra Boulevard in the vicinity of the county line. The route selected begins at the intersection of Mission Street with Sickles Avenue; thence along Sickles Avenue to Plymouth Avenue, to Sadowa Street, to Orizaba Avenue, to Stanley Street, thence along Worcester Avenue to the Junipero Serra Boulevard. This route is paved as far as Orizaba Avenue. On account of the low assessed valuation of the property fronting Worcester Avenue, it will be necessary to pay for a portion of this boulevard out of



View of San Francisco from Twin Peaks Boulevard

the Good Roads Fund. Probably \$20,000 will be appropriated for this purpose.

Great Highway:

It is essential that the Great Highway from the Cliff House to Sloat Boulevard be widened and suitably paved. This thoroughfare would be of military use as it connects Fort Miley with Fort Funston in the Merced Rancho, and is an essential link in the boulevard system. The Federal Government, however, did not believe the improvement of sufficient military value to warrant the expenditure during war times. It is hoped that the improvement will be undertaken immediately after the cessation of hostilities.

San Jose Avenue Widening:

The congestion of motor vehicles on Mission Road will be obviated by the improvement of the parallel boulevard along San Jose Avenue. Studies are being made for the widening of this thoroughfare and the pavement of its southerly course.

The following is a report on the official grades changed and established in the City and County of San Francisco during the fiscal year ending June 30, 1918:

Grade changes (379 blocks)	
(148 crossings).....	26.10 miles
Grade establishments (24 blocks)	
(8 crossings).....	1.90 miles
Investigations (245 blocks)	
(157 crossings).....	21.30 miles
Total	49.30 miles

Many of the districts in San Francisco were platted without regard for the contour of the ground. A right angle system of streets seemed to be the only plan followed by the surveyors who laid out our City, some grades being as steep as 50 per cent.

Many good improvements were built on these steep hillsides before the streets were improved, the builders

having no idea, nor making any inquiries where the street grade might be.

After a number of homes were built haphazardly on one of these steep hillsides, it became necessary to construct sewers for sanitary reasons. Grades had then to be established to conform, as closely as possible, to existing improvements.

The accompanying photographs show some special grade treatments provided in such cases:

BUREAU OF ENGINEERING
AMOUNT AND COST OF STREET WORK—PUBLIC
Fiscal Year Ending June 30, 1918

Asphalt (6" Base)		
W. S. 2"	228,489.06 sq. yds.	\$ 412,180.33
W. S. 1½" Binder 2"	2,282.60	4,827.78
W. S. 2½"	2,648.57	5,005.81
Basalt Blocks		
Gravel & Asphalt Filler..	4,718.76	16,987.60
Cement Filler	3,386.92	9,585.54
Gravel Filler	4,122.66	14,773.77
Vitrified Brick		
Hillside	802.77	2,528.75
Asphalt with Basalt Strip		
W. S. 2"	1,633.40	3,908.13
W. S. 2½"	1,737.55	3,284.40
B. B. Gravel Filler.....	932.16	3,581.06
Asphalt with Vitrified Strip		
W. S. 2"	43,928.67	80,471.47
Hillside Brick	13,499.16	45,874.26
Broken Rock	1,666.66	450.00
Cobbles	173.01	513.86
Curbs		
Granite—new	23,159.17 lin. ft.	23,131.17
Granite—reset	1,038.07	409.86
Granite—redressed	198.90	3 98
Concrete	97,527.62	67,643.53
Gutters		
Bas. Blocks	938.72 sq. yds.	3,758.61
Art Stone Walks.....	37,441.71	41,499.05
Grading		
Cut		121,857.67
Fill		21,702.44
Forward		\$883,979.67

BUREAU OF ENGINEERING

AMOUNT & COST OF STREET WORK CONTINUED—PUBLIC

	Number	Lin. ft.	Cost
Brought forward			\$883,979.67
I. S. P. 6"		2,671.90	3,847.50
I. S. P. 8"		15,779.16	23,478.12
8" Y's	684		745.24
I. S. P. 12"		7,116.89	19,963.14
12" Y's	338		510.07
I. S. P. 15"		2,317.77	3,115.77
15" Y's	46		106.96
I. S. P. 18"		2,235.33	6,588.82
18" Y's	108		237.54
I. S. P. 21"		1,434.00	4,452.60
21" Y's	75		171.75
I. S. P. 10"		8,712.78	10,287.65
Manholes			
New	133		10,175.50
Rebuilt	1		25.00
Catchbasins			
New	316		23,004.50
Reset	10		375.00
Stairs (7)			1,005.00
Pipe Railings		707.00	2,646.98
Coping		134.02	330.02
Concrete Sewer		34.00	255.00
Traps	50		150.00
Concrete Walls		181.00	3,500.00
Retaining Walls, etc.....			11,112.00
Construction a/c			21,000.00
Total			\$1,031,063.83

BUREAU OF ENGINEERING
AMOUNT OF COST OF STREET WORK—PRIVATE

Fiscal Year Ending June 30, 1918.

Asphalt (6" conc. base)		
W. S. 2".....	117,669.56 sq. yds.	\$242,877.08
W. S. 1" Binder 1½".....	1,111.11	2,200.00
Basalt Blocks		
Gravel & Asphalt Filler.....	735.77	2,185.20
Gravel Filler	513.95	1,156.40
6" concrete base cement filler.....	33.33	186.00
Vitrified Brick (Hillside).....	2,351.11	7,425.79
Asphalt with Basalt Block Strip		
Asphalt W. S. 2".....	1,478 77	3,222.37
B. B. Gravel Filler	770 00	2,604.28
Asphalt with Vitrified Brick Strip		
Asphalt 2" W. S.....	19,018.81	42,066.92
Vit. Strip	9,190.20	32,143.17
Broken Rock	2,555.55	2,300.00
Cobbles	909.00	2,054.37
Curbs		
Granite, new	3,957.26 Lin. ft.	4,237.04
Granite, reset	2,072.18	1,216.63
Concrete	59,911.74	45,992.00
Gutters		
Basalt blocks	224 81 sq. yds.	620.93
Vit. Brick	233.33	735.00
Walks	7,019.49	7,723.60
Grading		
Cut		28,131.52
Fill		11,042.08
Forward		\$440,120.38

BUREAU OF ENGINEERING

AMOUNT & COST OF STREET WORK CONTINUED—PRIVATE

	Number	Lin. ft.	Cost
Brought forward			\$440,120.38
I. S. P. 8"		17,844.25	\$ 37,853.50
8" Y's	1,078		1,184.75
I. S. P. 12"		6,457.16	38,385.15
12" Y's	878		898.00
I. S. P. 15"		3,250.95	10,643.87
15" Y's	153		179.50
I. S. P. 18"		1,597.80	6,391.78
18" Y's	52		78.00
I. S. P. 10"		3,921.50	5,123.08
Manholes			
New	165		13,045.00
Rebuilt	2		50.00
Catchbasins			
New	135		11,040.00
Reset	4		155.00
Lamp Holes	10		150.00
Total			<u>\$565,298.01</u>

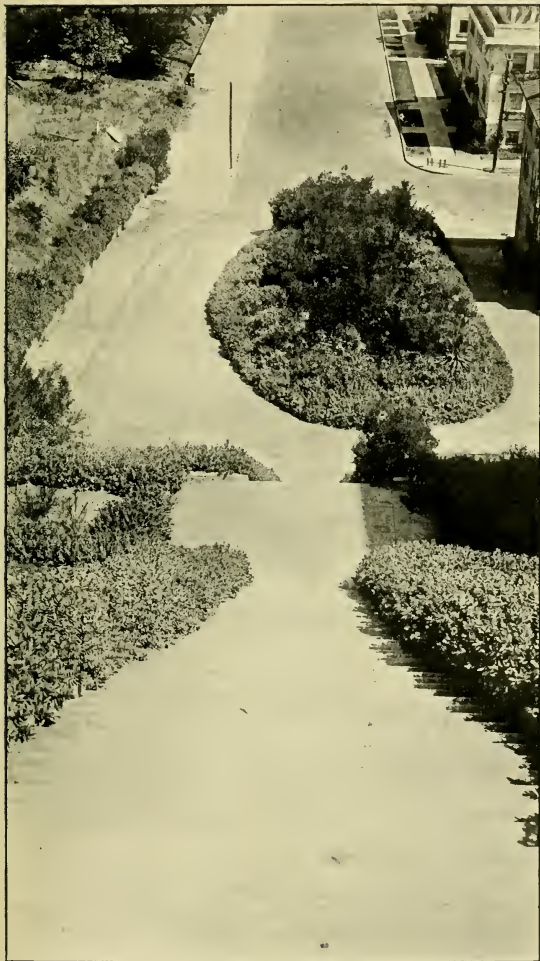
BUREAU OF ENGINEERING
AMOUNT AND COST OF STREET WORK—CITY PAY

Fiscal Year Ending June 30, 1918,

Asphalt		
Topeka Mix 2" W. S.	12,274.55 sq. yds.	\$19,884.78
W. S. 1" Binder 1½"	1,123.97	2,245.47
Basalt Blocks		
Gravel Filler	17.55	40.00
Reconstructed	90.66	301.55
Gutters		
Basalt Blocks	13.33	54.00
Brick	895.11	3,061.28
Curbs		
Granite, new	266.90 lin. ft.	293.59
Concrete, armored	4,054.00	2,594.56
Art Stone Walks	4,071.56 sq. yds.	4,179.55
Grading		
Cut		770.40
Fill		888.00
Sewers		
12" pipe	74.00 lin. ft.	111.00
15" pipe	550.00	1,045.00
15" Y's	5	9.50
10" pipe	735.00	735.00
Manholes	2	
Catchbasins (new)	17	1,360.00
Rebuilt	1	25.00
Extra Work		1,092.08
Total		<u>\$38,840.76</u>

SUMMARY

Public	\$1,031,063.83
Private	565,298.01
City Pay	<u>38,840.76</u>
GRAND TOTAL	<u>\$1,635,202.60</u>



Special Treatment
Lyon Street, looking northerly from Vallejo Street
Brick and Asphalt Pavement and Concrete Stairs

DIVISION OF SURVEYS

ANNUAL REPORT JULY 1, 1917, TO JUNE 30, 1918

During the fiscal year a total of 1236 orders for Surveys were received. Of these 44 were for lot surveys and 1192 were for surveys for public improvements and in answer to petitions or complaints. They include 3675 Blocks and Crossings, a total length of 1,530,000 lineal feet or 289.8 miles.

Precise levels were run covering about 64 miles; total number of bench marks rechecked and established, 2737.

Fees collected and turned over to the City Treasurer, \$14,723.50.

NUMBER OF MAPS ON FILE JUNE 30, 1918.

Subject	Tracings	Negatives	Originals	Duplicates	Total
1432	1862	1671	1220	1894	8082

Following is a detailed description of the work performed:

Made for	Number of Surveys
Public Contracts.....	126
Private Contracts.....	123
Resurveys for Contractors (Lost points, etc.).....	170
Examinations, Public Improvements.....	270
Street Repair Department	57
Sewer Repair Department.....	3
Division of Streets and Sewers.....	50
Division of Grades.....	48
Division of Surveys.....	177
Board of Public Works.....	156
City Attorney.....	1
City Architect.....	10
Municipal Water Department.....	1
	— 1192

LOT SURVEYS

Private owners	23
City Architect	17
Bureau of Engineering.....	4
	— 44
Total	1236

Precise Levels:

During the fiscal year ending June 30, 1918, precise levels were run and bench marks established, corrected or constructed, as follows:

100 Vara District.....	376
50 Vara District.....	466
Richmond District	467
Sunset District	84
Western Addition	400
Potrero & So. San Francisco.....	198
University Mound	266
Mission and Horner's Addition.....	344
Other Districts	136

Total Bench Marks.....	2737
------------------------	------

Total miles of Precise Levels, 63.49.

**SUBDIVISIONS APPROVED AND FILED WITH THE
RECORDER**

Title	Date Filed in Hall of Records
Claremont Court, Parcel No. 2 (in 3 sheets).....	August 24, 1917
West Portal Park (in 5 sheets).....	August 7, 1917
May of Addition to Mission and 30th St. Ext. Home- stead	September 1, 1917

FEES RECEIVED FOR SURVEYS

	For Public Improvements	For Private Improvements	Total
1917			
July	1177.75	101.00	\$1278.75
August	1803.75	95.00	1898.75
September	1842.00	25.00	1867.00
October	1012.00	25.00	1037.00
November	1539.25	50.00	1589.25
December	1094.00	73.00	1167.00
1918			
January	1195.50	70.50	1266.00
February	660.50	25.00	685.50
March	1053.00	110.00	1163.00
April	1071.00	50.00	1121.00
May	899.50	33.00	932.50
June	717.75	.....	717.75
Totals	14066.00	657.50	\$14723.50
GRAND TOTAL			\$14,723.50

MAPS PREPARED AND FILED WITH THE RECORDER FOR THE CLOSING,
OPENING AND WIDENING OF THE FOLLOWING STREETS,
JULY 1, 1917, TO JUNE 30, 1918 (INCLUSIVE)

Date Filed with Recorder	Name	Resolution No.	Date of Approval B. P. W.
Aug. 22, 1917	Potrero Ave., Serpentine to San Bruno	54022 (2nd Ser.)	July 18/17
Sept. 12, 1917	(Ext. Chenery St., Castro to) (Chilton	53982 (2nd Ser.)	July 16/17
	(Diamond, Wilder to Bosworth)	53982 (2nd Ser.)	July 16/17
Oct. 24, 1917	Texas St., Nly. & Sly, from 22nd St.	55514 (2nd Ser.)	Oct. 15/17
Oct. 24, 1917	22nd St., Ely. & Wly. from Texas St.	55514 (2nd Ser.)	Oct. 15/17
Oct. 24, 1917	Missouri Street	55514 (2nd Ser.)	Oct. 15/17
Oct. 24, 1917	Sierra Street	55514 (2nd Ser.)	Oct. 15/17
Oct. 31, 1917	De Forest Way.....	55559 (2nd Ser.)	Oct. 17/17
Dec. 26, 1917	Tivoli Way, bet. 17 & 18 Av.	56461 (2nd Ser.)	Dec. 10/17
Dec. 26, 1917	Wawona St., bet. 17 & 19 Av.	56461 (2nd Ser.)	Dec. 10/17
Dec. 26, 1917	Railroad Ave. at Intersn. of Yosemite Ave. & Lane St.	56462 (2nd Ser.)	Dec. 10/17
Jan. 10, 1918	Railroad Ave. at San Bruno	56781 (2nd Ser.)	Dec. 31/17
Jan. 10, 1918	Girard Ave. at San Bruno...	56781 (2nd Ser.)	Dec. 31/17
Mar. 25, 1918	Telegraph Place Ext.....	58136 (2nd Ser.)	Mar. 25/18
Apr. 8, 1918	Yukon Street Ext.....	58308 (2nd Ser.)	Apr. 8/18
May 8, 1918	Diamond St., Wilder to Chenery	58729 (2nd Ser.)	May 8/18

SUMMARY OF SPECIAL PROJECT SURVEYS

Resubdivision of Water Front Land Company's property located in Hunter's Point District, between Evans Avenue and Innes Avenue, and Innes Avenue and Keith Street and Griffith Street. Surveys were made and a filing map prepared showing location of new streets on the contour plan. Said map is now in the hands of the owners to be approved and signed.

Resubdivision of that portion of the Sunset District between 10th and 17th Avenues and Kirkham and Pacheco Streets. Surveys were made, a relief map prepared, and a map drawn showing the location of new streets on the contour plan. The blocks are now being replatted.

The drawing of a 100-foot scale map of the entire city drawn to a scale of 100 feet to the inch, comprising 354 sheets 21 by 28 inches each, is being prepared. The

Contract	Contractor	SEWERS		Amount Expended Prior to 7/1/17 (	7/1/17 to 7/1/18 (	Total (	Date of Acceptance	Fund
		Date of Award	Date of Signing					
Orizaba & Stanley Streets	D. L. Bienfield	1/17/17	2/20/17	(\$19,337.66)	(\$10,147.23)	(\$29,484.69)	12/14/17	General 1904
Outfall for Jackson St. Sewer at Pier No. 3	Contra Costa Constr. Co.	1/17/17	2/7/17	7,995.00	7,995.00	7,995.00		General
Dredging around Outfall of Pierce St. Sewer	Healy Tibbitts Constr. Co.	5/4/17	5/18/17	1,965.95	1,965.95	1,965.95	7/11/17	General
7th Ave. Extended & Dewey Blvd. Sewer	D. L. Bienfield	6/15/17	6/27/17	8,160.89	8,160.89	8,160.89		General
Commercial St. Sewage Pumping Station	H. A. Klyce	3/19/18	3/19/18	5,804.24	5,804.24	5,804.24		General
Lakes & 22nd Ave. Relief Home	Hugo Lotzin	9/28/17	11/11/17	25,074.80	25,074.80	25,074.80		General
Phelps St., Donner to Williams St. Sewer	L. F. Lorenz	3/11/18	3/20/18	5,948.27	5,948.27	5,948.27		General
Trocadero Sewer, 19th to 24th Ave.	D. L. Bienfield	10/5/17	10/22/17	31,880.30	31,880.30	31,880.30	6/14/18	1904 General
						\$117,443.06		
BOULEVARDS								
Marina Blvd., Laguna St. & Beach St.								
Steiner St. at Tonquin Street	Felix McHugh	12/31/18	1/8/18		40,910.99	40,910.99		Good Roads
Marina Blvd., Fill. Buchanan to Scott	J. P. Holland	6/28/17		1,451.00	261.30	1,712.30		Good Roads
Marina Blvd., Fill. Buchanan to Scott	J. O. Shea	6/28/17			631.50	631.50		Good Roads
Railroad Ave. Hollister to San Bruno	J. P. Holland	4/28/16	5/24/16	3,296.05	246.72	3,543.37	8/29/17	Good Roads
						\$46,798.16		
MISCELLANEOUS								
High Pressure Mains, Clifford Street, Ashbury St. & Upper Terrace	Thos. A. Clark	7/20/17	7/27/17		1,315.97	1,315.97	8/28/17	1908 AWS Bonds
Relief Home Pumping Equip. & Bldg	Simonds Machinery Co.	3/27/17	7/5/17		7,705.07	7,705.07	9/26/17	General
Drilling Well, City Hall Property	J. B. Rogers	1/24/17	6/12/17		1,397.93	1,397.93	8/15/17	Civ. Cen. Bonds
Westerly Half Hampshire St. 17th to Mari- posa	D. J. Counihan	4/9/17	4/26/17		2,983.47	2,983.47	8/15/17	Mun. Ry. Fund
Laidley St., Mateo to Roanoke St.	J. P. Holland	11/28/17	12/17/17		2,012.00	2,012.00	3/6/18	Mun. Ry. Fund
Imp. of Sanchez St. & Liberty St.	O. G. Ritchie	4/8/18	4/20/18		1,057.50	1,057.50		Mun. Ry. Fund
High Pressure Main, Clarendon Ave. bet. Burnett Ave. & Stanyan St.	Thos. A. Clark	2/27/18	3/12/18		3,339.90	3,339.90	4/12/17	1908 AWS Bonds
						\$19,811.84		

skeleton drawings and tracings are completed and are now being numbered.

Market Street Extension from Ord Street to 24th Street: Preliminary surveys, plans and estimates made and assessment district outlined and forwarded to the Supervisors.

Olympus Boulevard from 14th and Alpine Streets to 17th and Clayton Streets: Surveys, plans and estimates were made and assessment district outlined. Final report showing amounts to be paid for property damaged and to be acquired and assessments to be paid for by each separate piece of property in the assessment district, are now in the hands of the Supervisors.

Industrial Tract: Maps prepared and descriptions of streets to be closed and opened south of Army Street, between San Bruno Avenue and 3rd Street, are now in the hands of the Supervisors.

Holly Park Monument Map—District bounded by Mission, Cortland, Andover, Crescent and Leese Streets. Extensive monument line surveys and computations are being made. A map showing all Block dimensions and location of improvements is being prepared.

Sunset District Monument Map—District bounded by Lincoln Way, 19th Avenue, Sloat Boulevard and Great Highway. Monument lines carefully run and measured around entire district; monument line of Taraval Street established and all improvements on Taraval Street between 18th and 37th Avenues and on 19th Avenue between Lincoln Way and Taraval Street located.

Richmond District Monument Map—District bounded by Geary Street, 24th Avenue, Fulton Street and 47th Avenue. Monument lines run and monuments set and a map drawn showing location of all improvements covering 35 blocks.

Hunter's Point Boulevard Monument—Monument lines run and monuments set on Hunter's Point Boulevard, between Railroad Avenue and Alvord Street.

SEWER SYSTEM

In common with the experience of other large cities, San Francisco has found it necessary to reconstruct and re-design its sewer system. As early as the year 1876 the question of the establishment of an adequate sewer system was taken up and the Board of Supervisors at that time instructed the City and County Surveyor to prepare plans for such a system. His report, dated May 22, 1876, points out some of the defects in the system which exist to some extent today, namely, the needless construction of 3 by 5 ft. brick sewers in a large number of streets without regard to the drainage they were to carry, and the intersecting of all sewers, thus allowing the flow to be diverted or split and not confining it to any particular route.

As in a measure accounting for the fact that a large number of the sewers are also too small to carry off the storm waters properly, the above report recommends that a maximum rainfall rate of $\frac{1}{4}$ -in. per hour be used in the design of new sewers. This recommendation utterly ignores what is now universally regarded as of prime importance in the problem of sewer design, namely, the time element. In contrast to the practice recommended, this office is now using, in the design of new sewers, a rainfall rate corresponding to a storm of one hour duration, equal to 0.598 in., while for a period of concentration of 5 minutes' time, a rate of 2.16 in. per hour is used.

It is significant, however, that this old report recommended the adoption of Black Point as the ultimate outfall point for the major portion of the city's sewage and that this point is in close proximity to the one which has been selected for this purpose in the more recent report of 1899, on a system of sewerage, and finally adopted. In endeavoring to utilize the existing sewers, an examination was made for the purpose of ascertaining their condition, which in a large number of cases was

found to be very poor. The common brick in brick sewers had worked out where the grade was steep, and the vitrified pipe had also been cut through under similar conditions. A common defect found in the old brick sewers was the lack of mortar in the brick. In pipe sewers a lack of mortar in the joints was noted, thus permitting a constant flow of sand from the street, causing settlement of the pavement.

A small amount of cement-pipe sewer was found, ranging in size from 10 to 18 in., and this has invariably gone to pieces. It is necessary to state, however, that such sewers were manufactured and laid many years ago when materials and workmanship were not as good as they are today. Where filled in areas overlie old tide and swamp lands, the sewers within the area were generally found, after the earthquake of April, 1906, to have been so severely shaken, twisted and displaced as to be almost useless. Sewers on original ground were not affected by the vibration and shock.

The work which has so far been done in reconstructing the sewer system has been mainly financed by two bond issues. The first issues was for \$7,248,000, bearing $3\frac{1}{2}\%$ interest and voted in 1904. Owing to the low rate of interest, these bonds were found in 1908 to be unsalable, and \$5,254,800 was cancelled. In 1908 a new issue of bonds to the amount of \$4,000,000 was voted, bearing 5% interest.

There has been expended, therefore, on the Sewer System from these two bond issues, the sum of \$5,875,000 in round numbers, including premiums of the five per cent bonds. It is generally estimated that the cost of construction during the year in which the work was performed has advanced from twenty to twenty-five per cent since 1904, which would make it necessary to expend about \$8,875,000 in order to accomplish the same amount of work contemplated in the original bond issue of \$7,248,000.

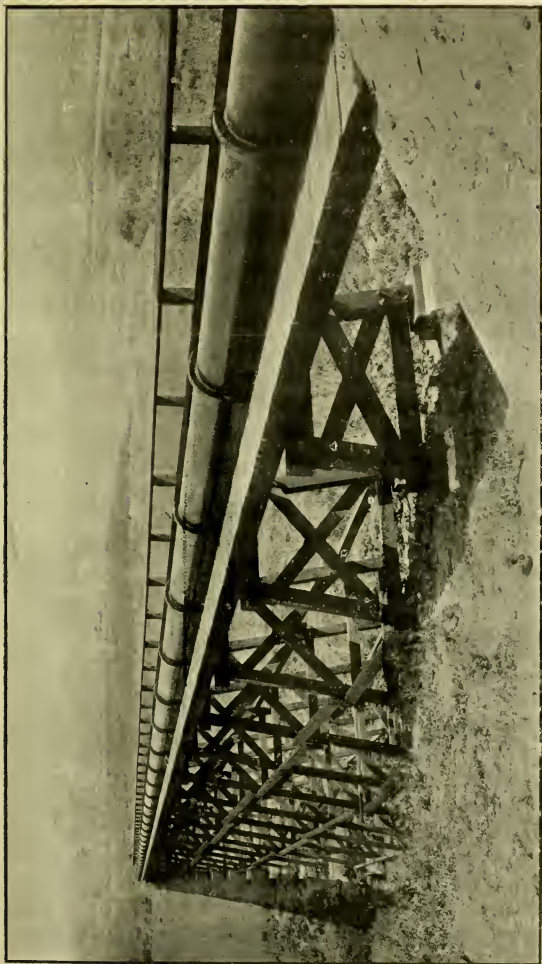
In addition to this it is now found that temporary points of discharge which were considered safe at the time the first report was made have, owing to increasing population of outlying districts since the fire, become a menace to the health of the community. I refer especially to the conditions and districts in and along Islais Creek, and parts of the Sunset and Richmond Districts. This work, additional to that contemplated in the original bond issue, which the City should now build, amounts to \$1,000,000 which, with the \$8,875,000 that the originally contemplated work will cost, totals to the sum of \$9,875,000 as the cost of a complete sewer system today. Deducting the \$5,875,000 already spent or available, the remainder required to complete the system to present needs is \$4,000,000, which should be supplied through the medium of another Sewer Bond Issue. I recommend that every effort be made to put the proposition of issuing these bonds before the people as soon as the financial circumstances of the City and the nation at large will permit and upon being so instructed this office will proceed with the preparation of a map and tabulated statement showing in detail the work already done and the work proposed with the bond issue recommended. This recommendation is a renewal of that made by me in a communication to the Board of Public Works under date of October 14, 1912.

During the past fiscal year the Sewer System has been developed to the ultimate limit possible with the funds therefore provided for its construction. The work completed since July 7, 1917, is as follows:

Jackson Street Outfall:

In January, 1917, the State Board of Harbor Commissioners called for bids for the construction of a new pier at the foot of Jackson Street.

At the same time, plans and specifications were prepared by the Board of Public Works for a main sewer outfall under the proposed pier. Contracts were awarded



Stanley Street Sewer through Spring Valley Water Company's property

to different firms but the commencement of work on the sewer was postponed until the dock was sufficiently advanced to permit of continuous unobstructed sewer construction. The consequent fifteen months' delay worked a hardship on the contractor, since the rapid advance in labor and material cost had, during that period, greatly exceeded the prices bid.

The Jackson Street outfall is a wood-stave pipe sewer 18 inches in diameter.

The structure is hung on the concrete piles of the pier, with steel rods.

The submerged pipe discharges only during ebb tide. A gas trap over the overflow structure and a positive draft provides for disposal of sewer gases and prevention of nuisance in the vicinity of the docks.

Stanley Street Sewer:

This structure provides an outlet for the westerly portion of the Oceanview district. Starting at Orizaba and Palmetto Streets, and running to Orizaba and Sagamore Streets, is a 21-inch iron-stone pipe.

From the last named intersection to Stanley Street and westerly on Stanley to Russell Street, the sewer is of reinforced concrete, 2 feet by 3 feet, inside dimensions. At the corner of Stanley Street and Ramell Street, the structure is enlarged—the inside dimensions are increased to 2 ft. 6 in. by 3 ft. 9 inches.

Continuing along Stanley Street, the sewer crosses Stanley Street creek, in a concrete culvert supported on concrete piers, and extends to an overflow at St. Charles Avenue, so designed that when the 2 ft. 6 in. by 3 ft. 9 in. sewer is flowing at or near full capacity, the greater portion of the storm water and diluted sewage will pass over a weir into the Stanley Street creek; thence it will be conveyed across the Merced lands, through an existing wooden flume and through a tunnel direct to the ocean. Undiluted sewage, however, passes under the Junipero Serra Boulevard through a cast-iron pipe, which continues

across the Merced lands to Sloat Boulevard, where it discharges into the lower Sunset sewer, whose outlet is at Mile Rock.

During construction, where the contour of the ground permitted, a ditching machine was used, which not only produced cheaply a uniform trench in which to lay the heavy cast-iron pipe but speeded the completion and earlier use of the entire system.

The following is the cost to the contractor of some of the items—office overhead and the necessary insurance and bond are not included:

15 in. I. S. P.....	\$1.65 per foot
21 in. I. S. P.....	1.79 per foot
2x3 Std. reinforced concrete sewer.....	3.31 per foot
2 ft. 6 in. x 3 ft. 9 in. std. reinforced concrete sewer....	3.51 per foot
Brick manholes	40.50 each
Overflow structure	465.65

Trench excavation for the cast-iron pipe was in stiff sandy clay. The cost of that portion of the work done by hand was \$0.91 per cu. yd.; the cost by machine was \$0.18 per cu. yd., including a fixed charge of \$32 per day for the use of the machine.

The 18-in. cast-iron pipe cost \$0.228 per ft. to lay, yarn, pour and calk the joints.

The prevailing rate of labor during construction was \$3.00 per day.

Pierce Street Outfall Sewer Dredging:

The Pierce Street sewer, which traverses the Panama Pacific Exposition site and has an outfall into the Bay on the north shore along the line of Pierce Street, becomes blocked by an accumulation of silt as the result of tidal occurrence.

Intermittent dredging operations have been necessary to keep a suitable channel open, and plans should be prepared for extending the existing structure out into the Bay whenever funds become available.

Commercial Street Sewage Pumping Station:

To handle domestic sewage in the low level districts of the eastern portion of San Francisco, including the area bounded by Commercial Street, the Embarcadero, Howard Street, Second Street, the north side of Market Street, and Drumm Street to Commercial Street, the Commercial Street sewage pumping station has been rebuilt.

To provide for deep basements and a flow free from tidal influences, sanitary sewers were laid throughout this area, independent and deeper than the trunk storm sewers. These sanitary sewers all converge to the new pumping station at Commercial and Drumm Streets, from which the sewage is raised into the North Point main, a combined sewer which discharges at the foot of Grant Avenue.

The work of constructing a reinforced concrete pumping station and installing therein three centrifugal sewage pumps, motor-connected, which were formerly used in a brick sump near the site of the new station, was begun on March 26, 1918, and completed on May 1, 1918.

The pumps are 6-inch vertical shaft, direct-connected centrifugal, water-balanced type, and each provided with a 10-horsepower direct-current motor, operated by float switches, having a capacity of from 650 to 750 gallons per minute under heads varying from 15 to 25 feet.

Storm Relief Outlet for Lake Street Sewer:

In the winter of 1915, due to the rapid growth of the Richmond District and the attendant rapid runoff, the sewer in Lake Street was overtaxed during a period of heavy downpour. The excess flow from the Lake Street sewer found a course in a northerly direction along Twenty-second Avenue where, upon reaching the lower end of this avenue in West Clay Park, the water overflowed the sidewalks and started down the steep embankment into Lobos Creek. The result was the loss of considerable embankment and the serious disturbance of the waters of Lobos Creek, which constitute the water supply for the Presidio Military Reservation.

A similar condition existed on a small scale at other points along Lobos Creek.

The Lake Street sewer, constructed in 1893, 6 feet in diameter, having proved inadequate to provide ample protection to property during periods of heavy downpour, a solution of this serious condition was sought, resulting in the construction of the storm water relief outlet for the Lake Street sewer. The contract for this work was awarded on September 28, 1917, to Hugo Lotzin, and signed on October 11, 1917.

The contract called for the removal of a portion of the Lake Street sewer at Twenty-second Avenue and Lake Street, and the construction of a reinforced concrete overflow structure in its place. The existing Lake Street sewer was built of brick, and the portion removed presented evidence of excellent material and workmanship, being taken out with considerable difficulty. The bonding of the brick with the mortar was particularly strong.

The outlet of the overflow structure was a 4 ft. 6 in. circular reinforced concrete sewer, flowing north along Twenty-second Avenue, then tapering to a 3 ft. 0 in. circular reinforced concrete sewer running down a step slope to the south embankment of Lobos Creek. At this point the sewer tapered to a 5 ft. 6 in. heavy section crossing over the channel of Lobos Creek and continued as a lighter section through deep cuts until its final discharge into the Lobos Creek Channel, below the point from which the Presidio water supply is taken.

The 4 ft. 6 in. circular section was 420.3 lin. ft. in length. The three-ft. section was 100.3 lin. ft. in length, the 5-ft. circular heavy section crossing Point Lobos Creek was 50 lin. ft. in length and 5-ft. standard section was 962.1 lin. ft. in length. The taper from 3 ft. to 4 ft. 6 in. section was 10 ft. long, while taper from 3 ft. to 5 ft. was 14 ft. long. The 5-ft. standard section was warped and flattened for 20 ft. to pass under a 16-ft. cast-iron pipe, and the discharge of the same had a concrete spillway apron and wing walls.

Considerable ground water was encountered from the spillway end to the Lobos Creek crossing, and 10 in. underdrain with considerable pumping equipment was resorted to. The entire length of this work was solidly lagged with 2-in. vertical lagging and all excavation was staged to surface by hand labor.

Actual construction started on October 20, 1917, and the job was accepted on June 20, 1918. The difficulty in securing good bottom, due to fine sand and considerable water pressure, delayed the progress of the work at times.

The bid price for the work was \$21,989.50. The amount paid in settlement thereof was \$22,781.90, the underdrain being paid for as extra work. The actual cost of the work to the contractor was approximately \$27,000.

Phelps Street Sewer:

Sewers and appurtenances in Phelps Street, from Donner to Williams Avenue, and in Williams Avenue from Phelps to Apollo Street, have recently been completed.

The work, consisting of 800 lin. ft. of standard 2 x 3 reinforced concrete sewer, and 250 lin. ft. of 21 in. I. S. P. sewer, was completed and accepted in June, 1918.

Although this quite thickly settled district was bounded on one side by a large main sewer, it had up to this time no means of utilizing it.

Trocadero Sewer:

The contract for the Trocadero Sewer was awarded to D. L. Bienfield & Company on October 5, 1917.

This contract comprises 1648 ft. of 5 ft. 3 in. circular, reinforced concrete sewer, starting in Sloat Boulevard and Twenty-fifth Avenue, and extending easterly therefrom to a point off Nineteenth Avenue, 213 ft. north of Sloat Boulevard. The new work connects with a 5 ft. 3 in. circular sewer at either end and supplies the last link in the Richmond-Sunset sewer system, which is now com-

plete from the westerly ridge of Twin Peaks to the Mile Rock outlet under Sutro Heights.

The design of this sewer conforms to the standards employed on all San Francisco bond sewer work. The construction was performed under ideal conditions.

The trench opened was 7 ft. wide and practically 20 ft. deep for the entire length. The material excavated was a very hard clay and stood alone without timbering or any other support. Black powder was employed to loosen the ground; the material thus broken was shoveled into one-yard buckets and hoisted to surface by a steam derrick. The charge employed for breaking the ground was 1 lb. black powder to a vertical hole of 4 ft. deep and drilled in the center of the trench. These holes were drilled at 5 ft. intervals. The trench was dug in 5-ft. steps. This charge merely loosened the ground so that no picking was required.

This sewer is located in an easement through private property for 1200 ft. on a side hill slope through a eucalyptus grove. The trees averaged from 60 ft. to 80 ft. in height. The contractors had the right-of-way cleared of these trees ahead of the excavation. The clearing was done by a sub-contractor who accepted the felled trees in payment for the work.

A portable $\frac{1}{2}$ -yd. mixer, set up on the edge of the trench was employed in the concrete work. The trench being 20 ft. in depth, enabled the concrete to be chuted in place for 50 ft. each way; 100 ft. of forms constituting a full day's pour.

Seventh Avenue Sewer Extension and Dewey Boulevard Sewer:

To provide drainage for the Relief Home grounds and buildings and Forest Hill Tract, the sewer main in Seventh Avenue was extended from its old termination at the southerly end of the Laguna Honda reservoir, southerly for a distance of nearly 1900 feet.

No difficulties were encountered during the construction of this sewer which is only 9 ft. below the surface of the ground for practically its entire length. The material excavated was chiefly a sandy clay with a little loam. The southern end of the sewer crossed the fill made over the Laguna Honda Station of the Twin Peaks Tunnel.

A series of levels, taken during a 10-day period, indicated no settlement of the fill. The construction was thereupon carried across the fill and completed. The new sewer joins the 2 x 3 ft. sewer already built at Dewey Boulevard.

The sum of \$10,000 has been provided in the Budget for extending the main sewers for the next fiscal year. The program for the year contemplates the construction of the following sewers:

Guttenberg Street Sewer, Mission Street to Morse.

Extension of the Orizaba Street Sewer.

Guttenberg Street Sewer:

Work will be started shortly on the Guttenberg Street sewer, which provides an outlet for West End Creek and the West End Homestead District. This 2 x 3 ft. concrete sewer will extend from Mission Street, along Guttenberg Street, to Morse Street, and thence by a private right-of-way along the bed of the creek about 150 ft., where a substantially constructed intake will be built. The flood waters of winter will be handled through this structure, and obviate the washouts of Mission Street, which, in previous winters, have frequently occurred at this point.

A 15-in. I. S. P. connecting to the 2 x 3 ft. extends along Guttenberg Street from Morse to the first bend south of Morse Street, which will give an outlet for the sanitary sewerage of the West End Homestead District.

GARBAGE DISPOSAL

During the past fiscal year the special Committee appointed by the Mayor to investigate the methods of

collection and disposal of refuse, rubbish and garbage, and to prepare recommendations for the consideration of the Board, held a number of meetings at which were emphasized the need for improvement in the present unsatisfactory, inadequate and wasteful methods of collection and disposal of refuse in this City.

Dr. William C. Hassler, Health Officer of the City and E. P. Jones of the Bureau of Engineering, were appointed to investigate and report upon the methods of segregation, collection and disposal of refuse in this city.

Based upon this report and the observation of the other members of the committee, who also visited Los Angeles, there was prepared and submitted to the Board of Supervisors by the Special Committee under date of June 10, 1918, a report and recommendations to be considered with reference to the proposed methods of collection and disposal of garbage and rubbish in this city. The reports follow.

In the meantime there was considerable correspondence with the Garbage Utilization Division of the United States Food Administration in Washington and the Committee was urged to participate in a campaign for the utilization of garbage, which was inaugurated by the U. S. Food Administration to advise all State Administrators "to spread garbage utilization propaganda through their territory and urge upon housekeepers the necessity for keeping garbage (kitchen and table refuse) in a separate container from other house refuse.

"The Food Administration is anxious to encourage and help in this great saving measure. While the money loss is a serious one, the material loss is more serious. The housewife can be of very great help in pushing this movement. It is her duty to see that the kitchen table refuse from her home is used in the most advantageous way which conditions in her locality will permit."

"We trust you consider that utilizing the contents of the garbage pail is as important as does the Food

Administration, and that you will co-operate with us and with the State Educational Directors in every way possible."

Recognizing the need of bringing the methods of garbage and rubbish collection and disposal into line with the increasing consciousness of the advantage of conservation, the Committee also recognized the need of going slowly because of the great amount of educational work that has to be done along these lines. Some progress is being made, and it is expected that some satisfactory solution of the problem may be reached.

It is of interest to note here that the method of disposing of usable garbage by incineration is no longer advisable where conservation by reduction or otherwise is economically possible.

Since the purchase of the property and the plant of the Sanitary Reduction Works by the City, the former owners have been operating the plant for the destruction of all the city refuse and paying the City the sum of \$17,500 annually, or five per cent interest on \$350,000 of the total purchase price of \$400,000, the balance, \$50,000, being retained by the City and subject to become due and payable at any time after two years from the date of sale agreement, March 8th, 1909.

Under date of February 1st, 1918, the Sanitary Reduction Works notified the City that they were ready and willing to deliver possession of the plant and made demand for the balance of \$50,000 due on the agreement of sale. The reason for the demand was given as decrease in the amount of refuse and consequent income, increase in cost of all materials and increase of wages, all of which combined resulted in the plant being conducted at considerable loss. Arrangement was made to relieve the Company from monthly interest payment of \$1,458.34, and the Company agreed to conduct the operation of the plant for a few months longer.

The report of the special committee indicates the lines along which the whole question is being considered and, while there always is, and will be, much opposition to new methods, even though they be for the best, it is expected that this City will adopt and put into force such methods of collection and disposal as will conform to the requirements of conservation and economy.

Report of Special Committee on Garbage Disposal

San Francisco, June 10, 1918.

To the Honorable the Board of Supervisors:

Gentlemen: Your Special Committee delegated by you to the investigation of and recommendation upon the subject of garbage disposal begs leave to submit the following progressive report:

Your Committee has held many meetings on this subject, and has heard the opinions and protests of the representatives of Restaurant Men's Assn., Apartment House Owners Assn., Civic League of Improvement Clubs, Building Owners and Managers Assn., Scavengers' Union, attorneys and other representing interests desiring to bid upon and receive the contract for disposal of the city's garbage. In addition, all of the members of this Committee have made an investigation of the system of collection and disposal now prevailing in the City of Los Angeles, as well as that obtaining in other cities.

On March 28, 1918, we reported, and you adopted the following:

"Acting on the recommendation of Dr. Hassler and E. P. Jones, who were appointed at the preceding meeting to report on all disposal propositions submitted to this Board prior to January 1, 1918, it was unanimously agreed that there would be no further consideration of these proposals. None of these proposals were prepared with a view to conservation, and inasmuch as conservation along all lines is one of the greatest necessities of the present time, the propositions submitted previous to this year failing to meet the changed conditions."

Your Committee attached itself to the problem with an idea of obtaining the highest possible modern method of disposal, and considered carefully the element of possible revenues to the city. In addition, we have considered the subject of segregation of garbage, and the municipalization of both the collection and disposal of garbage and rubbish. We are advised by governmental experts and agents that it is of the utmost importance at this time, and will be for some years to come, that all cities of over 100,000

inhabitants obtain from garbage, by reduction or other process, all the food values that remain. Your Committee gladly acquiesces in this highly patriotic idea, and has practically determined on a policy of conservation.

On the question of whether it is better to reduce the garbage, and by reduction obtain from it the soap fats, glycerine, alcohol and tankage, or whether it is better to feed the hogs the so-called wet garbage for the raising of pork is an undetermined question either by your Committee or by the government experts on the subject.

Incineration: It is practically conceded that so far as general refuse is concerned incineration of all except the combustible rubbish has now become an antiquated method. At least it is conceded that to destroy possible food values by burning is an unwarranted waste, and therefore your committee has, so far as wet garbage is concerned, discarded any thought of incineration of same.

Dumping the Garbage: In the same manner and for the same reason, your Committee has, so far as wet garbage is concerned, discarded any idea of permitting, or recommending that it be permitted, the dumping of the valuable by-product in the ground, with the feeling that that also would be waste, but with the further idea that non-combustible rubbish and ashes be used for that purpose.

Segregation: Your Committee has decided upon and recommends to your Honorable Board in favor of a policy of segregation of refuse at the household. This can be accomplished without any additional cost to the householder, and after separation there will be, according to the reports in our hands, approximately 150 tons of wet garbage for utilization for future food products. The containers which are now used by the average householder for garbage, may be retained for wet garbage, and the householder can be permitted to use whatever receptacle to them seems best for depositing the dry rubbish or refuse.

Collection and Scavengers: Your Committee has given serious consideration to the subject of municipal collection of garbage and is in favor of same, but deems that this is an inadvisable time in which to embark in that enterprise, as well as we deem it inadvisable at this time to recommend municipal disposal of garbage and rubbish. We have, however, given consideration to the use of the incinerator recently built for the city and located in Islais Creek, and we are disposed to feel that the way has been pointed out to the scavengers whereby the cost of collection of garbage and rubbish can be cheapened, and that they might profitably use the Islais Creek Incinerator for combustible rubbish, and at a profit to the city. In regards to the present incinerator at Rhode Island

and De Haro streets, operated by the Sanitary Reduction Works, your Committee is of the opinion, except for some proposition which may change our views, that that plant is a thing of the past, a nuisance, and that its abolition would be a highly desirable proposition.

Restaurants and Hotels: Your Committee has deemed it advisable in the recommendations herewith made, and which hereafter follow, to exclude the garbage from the restaurants and hotels from the provisions of a proposition for bids, and for this reason: The down-town restaurants and hotels now obtain a revenue from this source; it is estimated that they receive approximately \$5.00 a ton for 100 tons of garbage a day. The garbage of these places is segregated in the highest possible degree, and is now being used for feeding hogs. The elimination of hotels and restaurants from the provisions of a proposal for bids will permit them to continue their present method of segregation and disposal, and will not violate the contract which they now have running over a period of from six months to two years covering same.

Time of Contract: Your Committee is of the opinion that any contract for the disposal of garbage, in view of the extraordinary conditions surrounding the nation at this time, covering a period of more than ten years would be a mistake, but believes that a ten-year period would be a very safe period on which a contract might be let.

Propositions Involving Building Plants That Will Become City Property : Your Committee has given much consideration to proposals involving a contract calling for the building of plants to be used by the contractors in the disposal of garbage for a period of time and then becoming the property of the city at the expiration of said contracts. It must be obvious to you that, while these propositions are alluring on their face, acceptance of same would be a mistake, for the reason that the contractor during the period of his contract would obtain all the profits out of the reduction or other method of disposal of garbage and rubbish, and the City would obtain at the end of the period a plant probably obsolete, but at least depreciated to a very considerable extent. It has occurred to your Committee and must occur to you that if contractors can bid for garbage disposal based upon making, out of investments running all the way from half a million to a million dollars, that profit, by the time their contract expires, it would be good financial policy for the City to make this profit during that period, and avoid the necessity of taking over a probably obsolete or depreciated plant at the end of the contract period.

Until such time as the bids are before us, your Committee, of course, cannot recommend definitely what propositions may be

accepted. We have before us, however, in tentative form the following propositions:

From—

Cobwell Corporation, agreeing to build necessary plants for disposing of city's waste and agreeing to turn said plants over to the city at the end of 20 years. It was estimated by the representatives of the Cobwell people that said plant would cost in the neighborhood of \$750,000.

In this connection your Committee desires to say that, in addition to Dr. Hassler and Mr. Jones, Supervisors Wolfe, Mulvihill and Gallagher took advantage of their attendance at the Supervisors Convention at Los Angeles, to make a thorough inspection of the Cobwell plant and system. It is only fair to say in this connection that the almost complete absence of odor and nuisances attached to this plant was remarkable. The Cobwell system consists of a secret reduction process, by which all of the values are obtained from the garbage and rubbish. This system, so we are informed, is the last word in reduction plants, and we found the plant up to date, almost odorless and in splendid running order.

D. O. Lively, submitting tentative proposal to dispose of garbage without cost to scavengers, pay the city in addition for the privilege of disposal and purchase, the Islais Creek incinerator for \$195,000.

William H. Williams, Jr., offering to dispose of all garbage and street sweepings if he were paid \$10,000.00 a month and allowed to operate the plant owned by the city.

Your Committee has had the benefit of a special report from a subcommittee, consisting of Dr. Wm. C. Hassler and E. P. Jones of the City Engineer's office, and have to some extent been guided by the recommendations contained in their report.

Recommendations: As noted above, we have recommended that the Board decide in favor of a policy of segregation of garbage. Having so decided in the matter of policy, your committee will then have prepared for submission to the Board, ordinances for your approval, carrying out the details of said policy.

It is further recommended, that the Clerk be directed to advertise proposals for bids for disposing of the garbage of the City and County of San Francisco, excluding, as above noted, hotels and restaurants.

Respectfully submitted,

ANDREW J. GALLAGHER.

E. P. JONES,

Asst. City Engineer.

EDWARD I. WOLFE,

JOSEPH MULVIHILL,

WM. C. HASSLER,

Health Officer,

Special Committee on Garbage Disposal.

Note:

As a member of the Special Garbage Committee I concur in all of the recommendations of the Committee with the following exceptions:

Under paragraph Restaurants and Hotels, page 3: I do not concur in the recommendation that the garbage of the hotels and restaurants be eliminated, as this deprives the City of a revenue that would amount to over \$100,000.00 per annum.

Recommendation, page 5: Under this paragraph I do not concur with the Committee in excluding hotels and restaurants in the calling for proposals for the disposal of garbage, and recommend that proposals be called for disposal of all of the garbage of the city.

JOSEPH MULVILHILL,

Supervisor



Page	
to 78 inclusive	
4	4
7	7
12	12
35	35
37	37
37	37
52	52
60	60
o 131 inclusive	
88	88
to 102 inclusive	
103	103
112	112
122	122
122	122
124	124
129	129
o 145 inclusive	
134	134
135	135
137	137
137	137
139	139
139	139
140	140
to 149 inclusive	
147	147
148	148
o 160 inclusive	
152	152
154	154
155	155
155	155
156	156
158	158
158	158
159	159
159	159
160	160
o 167 inclusive	

ANNUAL REPORT 1917-1918
 BLUE PRINTING, PHOTOSTAT AND PHOTOGRAPHIC DEPARTMENT

	Square Feet				Photo Negative				Photo. Prints															
	Blue		Black		Photostats																			
	Prints	Line	Line	Nega-tive	Cloth	Blue	Black	10½	15	5	8	4½	8"	4	5	8	8½	4	11	14	16	20	40	8"
City Engineer	34992	68244	4825	7184	4736	20	6755-	5230	719	83	.....	1-1511	8774	692	230	.....	.....	.....	.....	83	15	15	2	13
City Architect	7488	5257	91	125	178	.....	96	137	4	164	.....	.....	48	696	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Board of Health	45	.....	.....	.....	.....	.....	28	4086	61	.....	.....	.....	1680	28	.....	.....	.....	.....	9	20	9	.....	.....	.....
Fire Department	423	1090	.....	17	8	8	45	15	.....	.....	.....	.....	12	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
City Attorney .....	.....	48	.....	6	.....	.....	31	62	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Street Repair Dept.....	96	882	.....	9	.....	.....	.....	.....	.....	.....	.....	.....	198	8	.....	.....	.....	.....	16	16	.....	22	1	.....
Mayor's Office .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	147	35	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Municipal R. R. ....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Auditor .....	.....	.....	.....	.....	.....	.....	22	576	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Board of Supervisors ..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	42	8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Assessor	83	94	154	163	.....	.....	3	187	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Recorder .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Civil Service Comm.....	.....	.....	.....	.....	.....	.....	41	25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Sheriff's Office .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Street Clean. Dept.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Board of Works .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Board of Education .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	43127	75615	5070	7504	4922	28	7021	10399	800	249-	522	1	1738	5985	1494	230	16	25	108	46	16	2	13	.....

CONTENTS

	Page
MUNICIPAL RAILWAYS	4 to 78 inclusive
Present Status of Street Railway system in	
San Francisco	4
California Street Cable Railroad system	4
United Railroad System	7
Municipal Railway System	12
Mileage	35
Financial Statement	37
Extensions	37
The Arnold Plan	52
New Railroad Work constructed during the	
Fiscal year 1917-1918	60
HETCH HETCHY WATER SUPPLY	79 to 131 inclusive
Main Accounts	88
Charter Amendments	97 to 102 inclusive
Hetch Hetchy Railroad	103
Lower Cherry Power Development	112
Saw Mill Operation	122
Tunnel Aqueduct from Early Intake	122
Resolution passed by Board of Supervisors ..	124
Contract Work already executed ...	129
BOULEVARDS AND STREETS	132 to 145 inclusive
Marina Boulevard	134
Sloat Boulevard	135
Market Street Extension	137
Worcester Avenue Boulevard	137
Great Highway	139
San Jose Avenue Widening	139
Amount and Cost Fiscal Year ending June	
30, 1918	140
DIVISION OF SURVEYS	146 to 149 inclusive
Precise Levels	147
Special Project Surveys	148
SEWER SYSTEM	150 to 160 inclusive
Jackson Street Outfall	152
Stanley Street Sewer	154
Pierce St. Outfall Sewer Dredging	155
Commercial Street Sewage Pumping Station ..	155
Storm Relief Outlet for Lake Street Sewer ..	156
Phelps Street Sewer	158
Trocadero Sewer	158
Seventh Avenue Sewer Extention	159
Dewey Boulevard Sewer	159
Guttenberg Street Sewer	160
GARBAGE DISPOSAL	160 to 167 inclusive

ANNUAL REPORT

OF THE

Bureau of Engineering

OF THE

Department of Public Works

CITY AND COUNTY OF SAN FRANCISCO

Fiscal Year ending June 30, 1919

M. M. O'SHAUGHNESSY
CITY ENGINEER



Annual Report of the City Engineer

1918-1919

CITY AND COUNTY OF SAN FRANCISCO

Department of Public Works, Bureau of Engineering

San Francisco, September 13, 1919.

Honorable James Rolph, Jr.,

Mayor

and the

Honorable Board of Public Works of the

City and County of San Francisco.

Gentlemen: I beg herewith to transmit the annual report of the Bureau of Engineering for the fiscal year 1918-1919.

This report covers a period of strenuous times in municipal affairs, when the city was confronted with many unforeseen contingencies in finance and labor due to the pressure of war conditions.

While no new projects have been started, a great many of the old ones have been completed, and work for the furtherance of the Hetch Hetchy project has been well advanced, especially the preparations for the construction of the Hetch Hetchy Dam.

It is a matter of particular pride of this department that it contributed the largest percentage of fighting men, both in the ranks and as officers, in the military and naval service of the country, there being about thirty-five employees in active service out of a total of 125 in the department, which, I believe, is the largest percentage in any

branch of the municipal service of the City and County of San Francisco. While many of those men were under fire, I am glad to say that they all returned safely and should receive preferential consideration in matters of future employment by the city.

Very respectfully,

M. M. O'SHAUGHNESSY,
City Engineer.

MUNICIPAL RAILWAY SYSTEM.

The report for the fiscal year 1917-18 on the Municipal Railway System was very comprehensive, touching on a number of subjects other than the actual physical construction of tracks and equipment. There have been no marked changes in the conditions affecting the extensions of either the Municipal Railway or the United Railroads during the past twelve months. However, several things worthy of mention have been accomplished during the year.

Ferry Terminal:

In last year's report mention was made of the conditions existing at the Ferry terminal. In June, 1918, the cars of both the United Railroads and the Municipal Railway were operating over two loops; since then three betterments have been made to improve conditions at this terminal. One was the installation of a cross-over between the inner and outer ferry-bound tracks on Market street, near Spear street. This cross-over, electrically controlled by a tower man at the corner of Market and Spear streets, permits the switching of cars off the inner track when bound for the outer loop prior to their reaching the terminal. In order to utilize fully the advantages provided by this arrangement, it was necessary to reconstruct the inbound throat to the loop so as to permit cars on both the outer and inner tracks to pass into the loop together rather than for one car to be held back in order to clear the operation of a car on the parallel track. Conditions were greatly improved by these changes. Yet every morning and every evening for a short period during the rush hours there was considerable congestion of ferry-bound street railway traffic on lower Market street. From actual figures it is easy to see how the traffic at the loop has grown. In August, 1915, the conditions at the Ferry were as follows:

	8 to 9 A. M.	5 to 6 P. M.
Cars using outer loop.....	154	161
Cars using inner loop.....	71	87
	<hr/> 225	<hr/> 248

This was divided as follows:

U. R. R. cars using inner loop.....	71	87
U. R. R. cars using outer loop.....	85	85
Municipal cars using outer loop.....	69	76
	<hr/> 225	<hr/> 248

In April, 1918, conditions were as follows:

	8 to 9 A. M.	5 to 6 P. M.
Cars using outer loop.....	137	142
Cars using inner loop.....	81	102
	<hr/> 218	<hr/> 244

Divided as follows:

U. R. R. cars using inner loop.....	81	102
U. R. R. cars using outer loop.....	83	81
Municipal cars using outer loop.....	54	61
	<hr/> 218	<hr/> 244

The slight reduction in the number of cars was due to the 1918 schedules not including the service given to the Exposition in 1915. On June 1, 1918, when the cars of the J and K lines commenced operating over the outer tracks on Market street, thirty-four additional cars per hour had to be handled over the outer loop.

Among the several plans suggested for relieving the congestion during the rush hours was that of rearranging the then existing outer loop and the addition of a third loop outside of the two original loops. After the most careful consideration it was decided to adopt this plan, allowing the work to be done by the United Railroads, the Municipal Railway to pay the sum of \$7,123.00, which sum gave the city a half interest in the new loop, and retaining the half interest in the middle loop, permitting it to operate cars over both of these tracks. The United Railroads has the right to operate not to exceed fifty cars per hour over the new loop, while the city may operate as many cars as it desires without limiting the United Railroads' use of the loop to less than fifty cars above stated.

Through Mr. Wm. von Phul, at that time Vice-President and General Manager of the United Railroads, arrangements were made for the schedule of the cars to be operated over the various loops at the Ferry. This schedule, which was approved by the State Harbor Commission, contemplated the operation of 107 United Railroads cars per hour over the inner loop, thirty-four Municipal and forty-five United Railroads cars, a total of seventy-nine cars per hour over the middle loop; and sixty-three Municipal and forty United Railroads cars, a total of 103 cars per hour over the outer loop. These figures are for the evening rush hour period. Since the completion of the third loop there has been no reason to complain of congestion or delays at the Ferry terminus. The total number of cars now handled is 289 per hour.

Ocean Avenue Agreement:

In last year's report attention was called to the fact that the Twin Peaks Tunnel had been completed and that Municipal Railway car service had been established through the tunnel on February 3, 1918, but that no definite arrangement had been made for the construction of extensions of this line reaching the Ingleside and Parkside Districts. During the year the plan outlined below was prepared, and received the sanction of the Board of Supervisors in an ordinance passed on November 19, 1918: The United Railroads was to permit the Municipal Railway to connect with its double track line at Sloat and Junipero Serra boulevards and to operate its cars from that point over the private right of way of the United Railroads parallel to Junipero Serra boulevard; thence along Ocean avenue to Harold avenue or any avenue west of Harold avenue as might be selected by the city. Under the terms of the agreement drawn up, the city paid to the United Railroads, in December, 1918, for the privilege of operating over the route, the lump sum of \$100,000, and is further obligated to pay 7½ cents to the United Railroads for each car mile operated by the Municipal Railway cars over this route. This 7½

cents covers the use of the tracks and trolley wires and their maintenance, together with the power used by the cars.

The \$100,000 paid in December, 1918, may, however, be applied to the purchase of the line at any time, the sum of \$7000 being deducted for each year that shall have elapsed between the time of paying the \$100,000 and the date of purchase.

Work on the connection between the two roads was commenced immediately upon the passing of the ordinance, and the Municipal Railway cars running through the Twin Peaks Tunnel were placed in regular operation to the cross-over in the United Railroads tracks near Miramar avenue on February 21, 1919. Work was later completed on a Municipal Railway extension up Brighton avenue from Ocean Avenue to Grafton avenue, which was placed in service May 18, 1919. This line gives street railway service to the inhabitants of the Ingleside and Westwood Park Districts through the Twin Peaks Tunnel, to the cost of which they contributed through the tunnel assessment district.

Taraval Street Agreement:

The inhabitants of the Parkside District, who were without street railway service through the Twin Peaks Tunnel at the time of the last report, now have a municipal car line on Taraval street from Thirty-third avenue to Fifteenth avenue, thence via Fifteenth avenue and Ulloa street to the tunnel. This line, in addition to serving Parkside, gives service to the West Portal Park District. An Agreement with the United Railroads making such service possible was sanctioned by the passage of an ordinance on November 19, 1918. The city under contract built its own tracks from the tunnel to Twentieth avenue and Taraval street, and the agreement mentioned permits the cars of the Municipal Railway to operate over the United Railroads tracks on Taraval street from Twentieth avenue to Thirty-third avenue. In order to secure the privilege of operating

its cars over this track, the city agreed to reconstruct the existing tracks, bringing them to grade and supplying the necessary pavement. The future maintenance of this line will be shared on the basis of mileage operated by the respective companies, and the city will pay the United Railroads for such power as may be used off the United Railroads trolley wire, retaining the right to install trolley wires of its own should it so desire.

Thus during the past year these three traffic problems of great importance to the growth of the city have been settled on a satisfactory basis.

Many other features remain to be accomplished in connection with our street railway lines. Nothing has been done during the past year looking toward the unification of the United Railroads and Municipal Railway Systems. The necessity for additional lines into outlying portions of the city becomes more urgent each year. Some of the demands which are made for street railway service are unwarranted, and, if complied with, would serve districts of only very limited population and would not stimulate the growth of the city. Other requests for railway extensions are made because of real necessity. If it were possible to meet such demands, the new lines would not only serve an existing population, but would tend to increase the growth of the district served, encourage the building of new homes and attract residents to our city. At the present time there is no money remaining from the bond issues, and all of the available surplus which it has been possible to allocate to the building of revenue-producing extensions has been used. Furthermore, on account of the increased cost of materials and the advanced labor scales, it is impossible to look forward to the acquisition of future surplus funds which may be used for the purpose of extending the lines. The report for 1917-18 very clearly set forth the reason why the privately owned system could not be extended.

Street railway systems throughout the United States have been suffering from the increased costs of labor and materials, so much so as to impair their value for efficient

service. The condition throughout the Nation has become so serious as to warrant the present investigation of the subject by the Federal Government. Street railway corporations in the past made excellent returns upon the investment. Many of the railways are now approaching bankruptcy, and the cities which they have helped to build and of which they furnish the main arteries of traffic, no longer give them necessary support. San Francisco at the present time is not suffering as are many of the Eastern cities, where there has been not only a material advance in fares from 5 to 7 and 10 cents, but also a considerable deterioration in service. It is far more desirable for a city to maintain a high standard of service, meeting the demands of its people and creating favorable impressions among visitors to the city, than it is to maintain a very low fare.

At this time last year the city was operating a net trackage of 57.6 miles of single track. We are now operating 63.2 miles, a gain in mileage of 5.6 miles for the period.

Last year the operating figures included .99 mile of track operated jointly with the United Railroads. We are now using jointly 5.21 miles, a difference of 4.22 miles. Deducting this from the 5.6 miles increase during the year, indicates that the actual growth of the owned Municipal Railway trackage was 1.38 miles of single track. The additions to trackage has permitted our reducing the route miles operated by busses from 15.6 miles to 9.24 miles.

While the operated mileage is but 63.2 miles of single track, additional rails in car barns, on sidings, and for other utility purposes, not operated over by the passenger cars, amount to 3.78 miles, making the grand total of miles of single track 66.98.

CONTRACT WORK DURING THE FISCAL YEAR 1918-1919.

During the year, sixteen contracts for constructing tracks and for furnishing and delivering equipment and materials, were entered into. Of these, eleven were completed within the year and five are yet to be completed. The sum of the contract prices is \$186,367.80, and the actual amount paid out between July 1, 1918, and July 1, 1919, was \$138,184.73. Details of these contracts are set forth in the appended table, and more complete descriptions of the contracts follow:

Contract No. 98:

For the construction of the Taraval street line from its junction with the Twin Peaks Tunnel line at the West Portal of the Twin Peaks Tunnel, to a connection with the United Railroads at Twentieth avenue and Taraval street. This contract, awarded to A. J. Raisch on July 19, 1918, and later assigned to the Raisch Improvement Company, covered the construction of 7496 feet of single track and included the replacement of the pavement on accepted streets. The work was conditionally accepted on December 11, 1918, and finally accepted February 28, 1919. The line, however, was not placed in operation until after the reconstruction of the United Railroads tracks from Twentieth avenue westerly to Thirty-third avenue. On account of avoidable delays in the construction of the work the contractor was penalized to the extent of \$425.

Contract No. 104:

For furnishing and mounting automobile bus bodies. Five White Company's T. D. B. chassis were purchased under ordinance of the Board of Supervisors, and this contract, which was awarded to A. Meister & Sons Co. of Sacramento on August 23, 1918, contemplated the construction of automobile bus bodies and the making of the necessary changes in the chassis together with the mounting of the bodies on the modified chassis. One of these automobile bus

bodies (No. 06) was delivered during the second week in March. The remaining four, after being practically completed, were burned in a fire at Sacramento, which destroyed the Meister factory on March 27th. On account of the difficulty of securing a new manufacturing place, the Meister Company allowed their contract to lapse. A clause in the contract required that insurance in the sum of \$3600 be placed on each chassis. This insurance has been collected by the city on the four chassis which were destroyed. As no progressive payments had been made on the construction of the bodies it was unnecessary to make settlement with the Meister Company other than to pay for the chassis which had been delivered. This was done and the contract finally accepted on June 24, 1919.

Contract No. 105:

For furnishing and delivering copper trolley wire. On July 19, 1918, this contract was awarded to John A. Roebling's Sons Company, who furnished 21,508 pounds of 3/0 B. & S. gage, round copper trolley wire, for 33 $\frac{3}{4}$ cents per pound, making a total price of \$7178.30. This contract was completed and accepted on December 18, 1918.

Contract No. 106:

For furnishing and installing reinforced concrete trolley poles, Taraval street line. These poles were for use along the railway line constructed under Contract No. 98, as indicated above. John Spargo was awarded this contract on July 19, 1918. Due to avoidable delays, liquidated damages of \$135.00, in accordance with the terms of the contract, were exacted of the contractor. The final payment of the sum of \$7073.00 was made on February 17, 1918, at which time the work was accepted.

Contract No. 107:

For furnishing and installing electrical conductors along the Taraval street line, as indicated under Contract No. 98. Only one proposal was received on the date set for

receiving bids. The bid was rejected as excessive and the work was undertaken and completed by the Superintendent of the Municipal Railway.

Contract No. 108:

For furnishing and installing electric passenger elevator, Laguna Honda Station, Twin Peaks Tunnel. Bids under Specifications No. 13,774 were received on September 11, 1918. The only bid received was for \$23,400, and was rejected as being too high. Bids on new specifications were received on November 27, 1918. The new specifications called for a large gearless traction type elevator, and as alternate equipment a smaller capacity geared traction type of machine. The bids on the large elevator were still high, and on November 29th the contract for the smaller capacity geared traction type was awarded to the Otis Elevator Company for the sum of \$15,350. This work has been progressing very satisfactorily, and it is expected that the elevator will be ready to operate very shortly after August 1, 1919.

Contract No. 111:

For relocating the Union street line from Franklin and Union streets to Van Ness avenue. This change consists of the removal of the two blocks of track on Franklin street between Vallejo street and Union street and the block of track on Vallejo street between Van Ness avenue and Franklin street, replacing these three blocks of track with one block of track on Union street between Van Ness avenue and Franklin street and reconnecting the tracks on Vallejo street to Van Ness avenue, thus eliminating two unnecessary curves in the Van Ness avenue and Union street line. The tracks removed were a portion of the original Presidio and Ferries Railway purchased out of the 1913 bond issue, and as they needed to be reconstructed this opportunity was taken to shorten the line by relocating over the route indicated. The contract was awarded to Healy-

Tibbetts Construction Company on June 2, 1919, for \$21,274. On July 1, 1919, approximately 25 per cent of the work had been completed and a progressive payment in the sum of \$3750 had been recommended.

Contract No. 112:

For reconstructing Taraval street line from Twentieth avenue to Thirty-third avenue. This contract contemplated the raising of the tracks of the United Railroads to grade, the insertion of new ties where necessary and the paving of the railway track right of way in the street. This work was done in accordance with the agreement for joint operation over the Taraval street line of the United Railroads as set forth above. The contract was awarded to Eaton & Smith on December 30, 1918. Conditional acceptance was given April 18, 1919, and final acceptance on May 14th. On April 12, 1919, the cars of the Municipal Railway commenced operating over these tracks and the tracks between Twentieth avenue and Twin Peaks Tunnel, constructed under Contract No. 98.

Contract No. 113:

For furnishing and delivering track special work, was awarded to the United States Steel Products Company on April 14, 1919, and contemplated the delivery of 106,000 pounds of track special work. This contract is well under way, and it is expected that the material will be shipped from the factory about the middle of July.

Contract No. 114:

Sections A, B, C, and D, contemplate the furnishing and delivering of steel rail and track material. Sections A, C and D, covering rail, brace tie plates and flat tie plates, were awarded to the United States Steel Products Company February 21, 1919. Section B, covering tie rods, was awarded to the Payne Bolt Works on the same date. All of this material has been furnished and delivered.

Contract No. 115:

For furnishing and delivering wood ties, was awarded to the J. R. Hanify Company on March 31, 1919, and contemplated delivery of 8000 redwood crossties for track construction and maintenance work. On July 1, 1919, 90 per cent of the material had been delivered.

Contract No. 116:

For the construction of the Brighton Avenue Extension of the Twin Peaks Tunnel line from Ocean avenue to Grafton avenue, was awarded on March 31, 1919, to Blanchard, Crocker and Howell. Work was completed and cars commenced operating over the line on May 18, 1919.

Contract No. 118:

Awarded to H. S. Tittle on March 28th, covered the installation of trolley wires and poles over the Brighton Avenue Extension of the Twin Peaks Tunnel line. This work was completed May 18, 1919.

Contract No. 119:

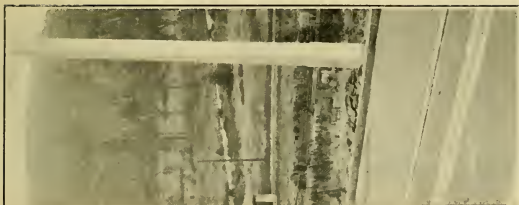
Awarded on June 2, 1919, to Eccles and Smith, covered the installation of trolley wires and poles over the new location of the Union street line as covered by Contract No. 111, and included the removal of the poles and wires from that portion of the Union street line which was abandoned; also the taking down of the trolley poles on Scott street between Greenwich street and Chestnut street where the tracks had been removed. This work is 50 per cent completed.

Miscellaneous Work:

In addition to work covered by contracts as indicated above, the installation of the tracks connecting the end of the Twin Peaks Tunnel line as originally constructed with United Railroads tracks at the junction of Sloat and Junipero Serra boulevards, was handled as an extra on Eaton and Smith's Contract No. 112. This was but a short piece

of line and connected at the United Railroads end with track special work installed by that company.

Due to copper declining in price and again commencing to rise, it was deemed best to buy some trolley wire for maintenance purposes. At the request of the Superintendent of Municipal Railways, Specifications No. 13943 were prepared covering three miles of 3/0 round copper trolley wire, which was purchased June 18, 1919, from the Pacific States Electric Company for 22.2 cents a pound.



nnel.

No.

98

104

105

106

108

111

112

113

114

114

114

114

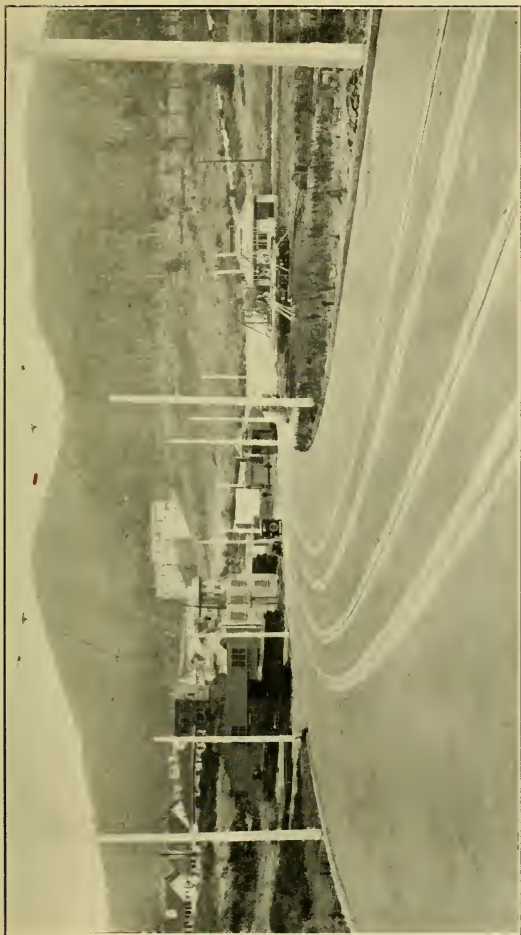
115

116

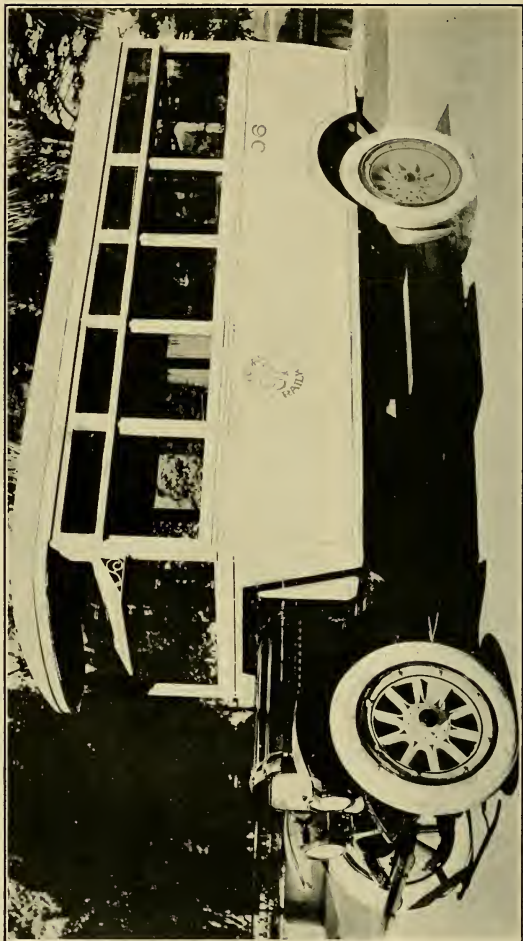
118

119

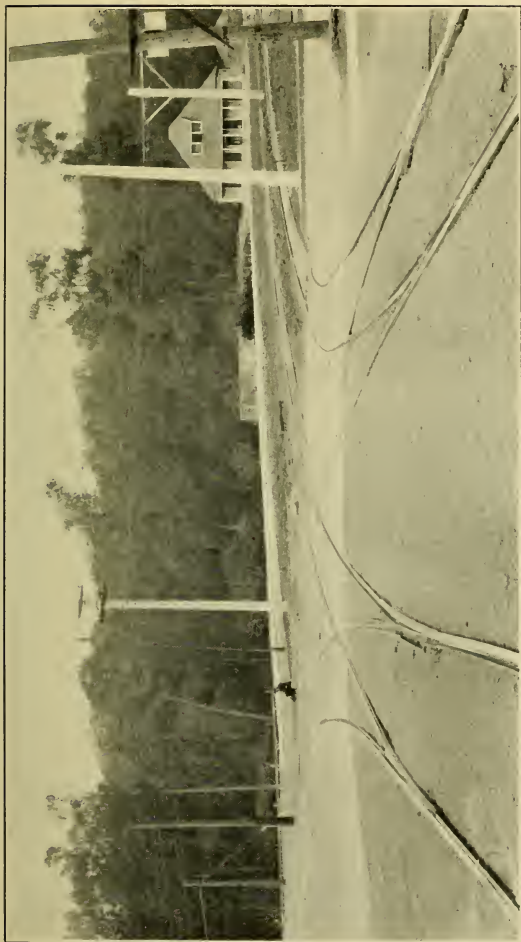
CONTINUED FROM PREVIOUS PAGE



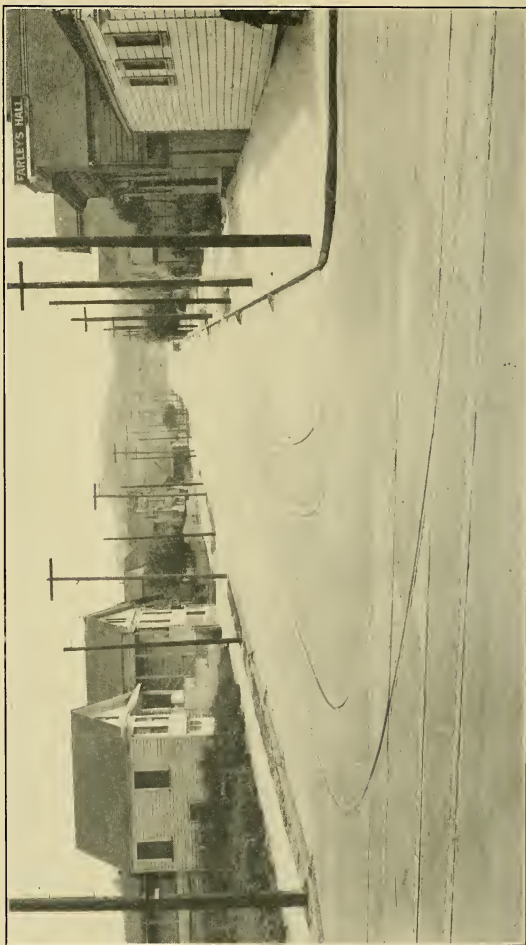
Municipal Railway on Ulloa Street looking toward West Portal of Twin Peaks Tunnel.



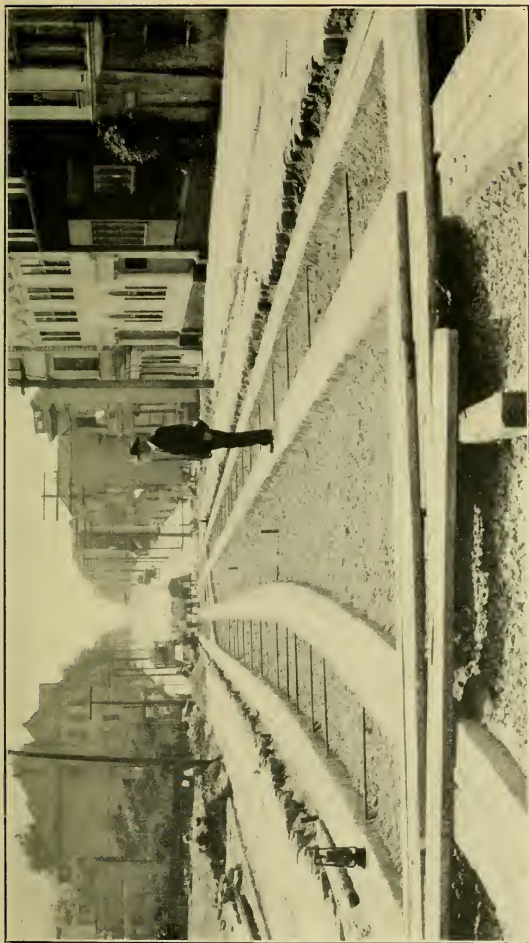
Municipal Railway Auto-bus of latest type.



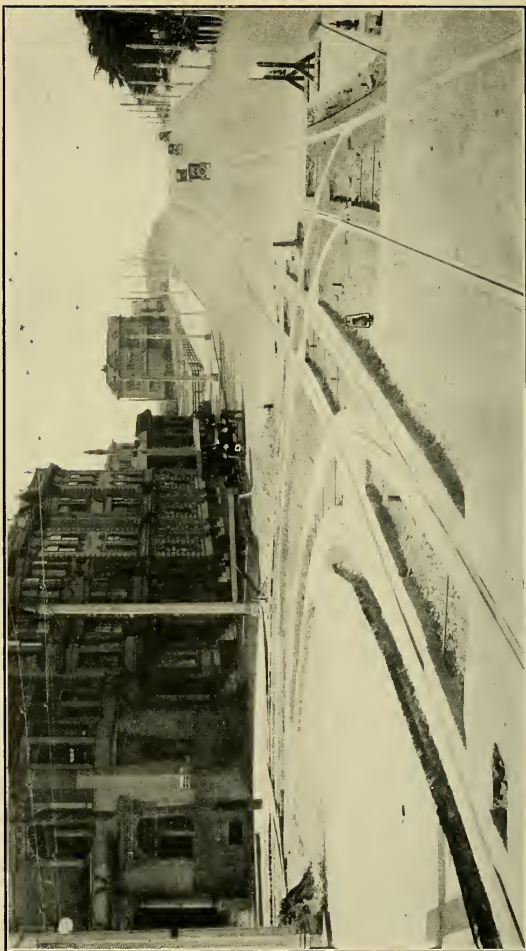
Junction of Municipal Railway and United Railroads tracks, Junipero Serra Boulevard and Portola Drive.



Municipal Railway tracks on Brighton Avenue.



Municipal Railway tracks on Union Street line relocation between Van Ness Avenue and Franklin Street.



Municipal Railway Branch-off at Van Ness Avenue and Union Street, Union Street Line Relocation.

BOULEVARDS AND STREETS.

The termination of the world war through the signing of the armistice found public improvements other than war necessities practically at a standstill throughout the country. The hysteria that eventually follows in the wake of such an upheaval took ready hold of the public mind, already reduced to a super-sensitive condition at the prospect of the payment of the stupendous war debt incurred during the period of hostilities. The spending of money for public improvements at such a time or for the years immediately following seemed inadvisable to the people.

Then simultaneously over the entire country came a popular demand for road construction. The majority of the States proposed highway bond issues that in previous times would have been deemed immoderate by reason of the large expenditure involved. It may be conservatively stated that before the end of the present fiscal year a billion dollars will have been appropriated throughout the country, through bond issues and other methods of appropriation, for the construction and improvement of highways. This would have been an astonishing figure in any past time, but the war has taught us to think in large figures. American highway engineers familiar with the situation agreed, after the battle of the Marne, that victory was made possible to the Allies through the excellence of the French road system, and that one of the great lessons of the war was the inadequacy of American highway construction, which emphasized the urgent need of providing immediately a suitable number of continental highways.

California recently voted almost unanimously for a highway bond issue of forty million dollars. When we consider that this sum far exceeds all former State bond issues for the same purpose combined, we see that the people are awakening to their needs.

It was to be expected that with the nation-wide ban placed by the Government upon road construction of other

than a military nature, the amount of highway and street improvements made here during the past fiscal year should have fallen short of the normal.

Four notable improvements were made, however: on Division street from San Bruno avenue to King street; on Sunnyside avenue from Acadia street to Circular avenue, and on Circular avenue from Sunnyside avenue to Joost avenue; on Army street from San Bruno avenue to Third street; and the St. Francis Circle improvement.

Upon representation being made by the City Engineer to the War Board that the Division street improvement was an urgent one for the reason that a considerable amount of war material was being moved over this thoroughfare even in its then unpaved condition, the work was allowed to proceed.

The grading of Army street from San Bruno avenue to Third street so that a branch electric road might be constructed to accommodate the large force of ship builders at the Union Iron Works, was of great importance. In establishing the new grades we had in mind the future use of this very important street as a short cross-town boulevard, and grades were limited to 3 per cent. The unsightly benched crossings were eliminated, and long easy gradients and vertical curves introduced. It is to be hoped that money will be available to finish this very important work in the near future.

The improvement of the easterly end of Sunnyside avenue was necessary to finish the work done the previous year upon that boulevard, to give access through Westwood Park and St. Francis Wood subdivisions and by way of Sloat boulevard to the ocean.

Finally, the construction of the St. Francis Circle, a long projected improvement, was necessary to provide a suitable traffic center for the several important boulevards meeting at that point. To make this improvement absolutely safe, a rotary system of handling the traffic will have to be introduced.

In planning the Circle, considerable ingenuity was necessary properly to harmonize existing conditions. In making this study the original plan of Olmstead Bros., landscape engineers, was used, but modified to some extent. The grades were worked up by this office after making a clay model, which was found to be a great help in solving the problem. Fifty-six thousand square feet of Topeka pavement were laid in St. Francis Circle.

With the close of the fiscal year, and following the signing of the armistice, came the improvement of the Great Highway, the city's greatest marine boulevard, $2\frac{3}{4}$ miles in length, and containing 536,000 square feet of surface. On the upper reaches of this boulevard the standard Topeka pavement $1\frac{1}{2}$ inches thick on a 6-inch concrete base forty feet in width is being laid. This is to be part of a final roadway width of 150 feet from Lincoln Way to the present northerly end of the esplanade. From Lincoln Way southerly to Sloat Boulevard, the upper road has been paved with a 2-inch Topeka surface over the old macadam surface. The paving of this section is now complete, and although of a temporary nature, it is believed that it will give many years of service. With the amount of money made available for this improvement, the only type of construction possible was adopted, the public demanding the paving of the entire length of the highway.

It is to be hoped that the city authorities will provide the necessary funds for quantity and quality in street improvements, so that San Francisco can keep pace with the country-wide movement for more and better roads. With over six million motor vehicles at present a wheel in this country, and the number rapidly increasing, street and highway construction becomes a most important factor in municipal development.

The amount and cost of street work completed within the year is as follows:

AMOUNT AND COST OF STREET WORK—PUBLIC CONTRACTS

(Contracts awarded by the Board of Public Works and paid for out of assessments against the property benefitted)

Fiscal Year Ending June 30, 1919

Street Pavements

Asphalt (6" base)

Wearing Surface 2".....43,267.2 sq. yds. \$97,562.45

Wearing Surface 1½"

Binder 2" 9,356 " 18,652.74

Wearing Surface 2½"..... 3,192 " 5,890.31

Asphalt (no base)

Wearing Surface 2"..... 147.7 " 213.21

Basalt Blocks (6" base)

Cement filler 35.7 " 64.32

Gravel 19.4 " 87.50

Basalt Blocks (on sand)

Cement filler 41.7 " 108.81

Vitrified Brick

Hillside 1,538.5 " 5,899.46

Asphalt with Basalt Block

Strip

Wearing Surface 2"..... 1,045.8 " 2,089.70

Basalt Block Gravel Filler..... 510.7 " 2,000.51

Asphalt with Vitrified Strip

Wearing Surface 2".....28,200 " 51,926.47

Hillside Brick 6,893.6 " 24,367.34

Broken Rock 340.3 " 581.88

Total Street Pavements.....94,388.6 sq. yds. \$209,444.70

Curbs

Granite (new) 4,878.3 ft. \$ 5,154.25

Granite (reset) 12 " 3.60

Granite (redressed) 52.6 " 16.10

Concrete31,426.6 " 22,850.05

Total Curbs36,369.5 ft. 28,024.00

Artificial Stone Sidewalks.....15,625.7 sq. yds. 19,761.35

Grading

Cut45,363 cu. yds. \$37,076.27

Fill13,757.1 " 7,963.20 45,039.47

Forward..... \$302,269.52

Brought Forward, \$302,269.52

I. S. P. Sewers

6"	115.5 ft.	118.65	
8"	4,318.6 "	9,202.36	
8" Y's	272 "	322.27	
10"	361.1 "	686.03	
10" Y's.....	27	29.70	
12"	1,175.6 "	3,311.85	
12" Y's.....	31	30.50	
15"	30 "	120.00	
18"	142 "	442.60	
10" Culverts.....	2,716 "	3,624.77	17,888.73
<hr/>			
Manholes (new).....	37		3,911.00
Catchbasins			
New	103	\$ 9,596.00	
Reset	2	120.00	
Storm water inlet.....	2	50.00	9,766.00
Pipe Railing	30.7 ft.		153.50
Concrete Walls	30.8 "		4,246.24
<hr/>			
Total.....			\$338,234.99

AMOUNT AND COST OF STREET WORK—PRIVATE CONTRACTS

(Contracts entered into directly between the contractors and the property owners benefitted)

Fiscal Year ending June 30, 1919

Street Pavements

Asphalt (6" concrete base)			
Wearing Surface 2".....	25,375.1 sq. yds.	\$53,290.33	
Wearing Surface 1½"			
Binder 2"	1,291 "	3,872.91	
Basalt Block (on sand)			
Cement filler	7.6 "	25.00	
Asphalt with Basalt Block Strip			
Asphalt Wearing Surf. 2"..	34.4 "	80.44	
Basalt Block Gravel Filler	19.4 "	70.00	
Asphalt with Vit. Brick Strip			
Asphalt Wearing Surf. 2"..	5,106.7 "	10,336.11	
Asphalt Wear'g Surf. 2½"	733.3 "	1,320.00	
Asphalt Wear'g Surf. 1½"			
Binder 2"	733.3 "	1,320.00	
Vitrified Brick Strip.....	3,264.6 "	10,792.10	
Broken Rock	3,722.2 "	3,350.00	
<hr/>			
Total Street Pavements.....	40,287.6 sq. yds.		\$ 84,456.89

Curbs

Granite (new)	2,060.6 ft.	\$ 2,610.67	
Granite (reset)	92.4 "	64.68	
Concrete	15,054.9 "	12,080.93	
<hr/>			
Total Curbs	17,207.9 ft.		14,756.28

Artificial Stone Sidewalks.....	3,897.7 sq. yds.	4,359.31
--	-------------------------	-----------------

Grading

Cut	7,445.9 cu. yds.	\$ 3,976.11	
Fill	840.2 "	3,229.31	7,205.42

I. S. P. Sewers

8"	9,567.6 ft.	\$25,334.98	
8" Y's	530 "	532.75	
10"	1,563.1 ft.	4,417.62	
10" Y's	99	149.50	
12"	8,007.7 ft.	22,056.24	
12" Y's	424	552.50	

<hr/>	<hr/>	<hr/>
Forward.....		\$110,777.90

		Brought Forward, \$110,777.90	
15"	33.1 ft.	115.95	
18"	1,899.7 ft.	6,126.09	
18" Y's	132	378.00	
10" Culverts	562 ft.	623.00	60,286.63
Manholes (new)	83		7,694.00
Catchbasins			
New	24	\$ 1,965.00	
Reset	4	80.00	2,045.00
Lampholes (I. S. P.)	1		25.00
Concrete Wall	276.5 lin. ft.		850.00
			<hr/>
	Grand Total.....	\$181,678.53	

AMOUNT AND COST OF STREET WORK—CITY PAY

(Work paid for by the City and not charged against property owners)

Fiscal Year Ending June 30, 1919

Street Pavements

Asphalt (6" Concrete Base)

Wearing Surface 2".....	1,209.4 sq. yds.	\$ 2,622.17	
Topeka Mix Wearing			
Surface 1½"	6,876.9	"	12,107.67

Asphalt (no base)

Wearing Surface 2".....	623.3	"	678.60
Topeka Mix Wearing			
Surface 1½"	874	"	634.26

Basalt Blocks (6" Con. base)

Cement filler	267.3	"	1,365.20
Gutters (concrete)	33		62.30

Total pavements	9,888.9 sq. yds.		\$17,470.20
-----------------------	------------------	--	-------------

Curbs

Granite (new)	745.6 ft.	\$	247.40
Granite (reset)	127	"	34.59
Concrete	1,751.3	"	1,175.68

Total curbs	2,623.9 ft.		1,457.67
-------------------	-------------	--	----------

Forward.....	\$	18,927.87
--------------	----	-----------

		Brought Forward, \$		18,927.87
Artificial Stone Sidewalks.....	1,095.3 sq. yds.			1,355.90
Grading				
Cut	443.4 cu. yds.	\$	406.76	
Fill	4,616.6 "		2,848.59	3,255.35
Sewers				
4" pipe drain.....	25 ft.	\$	25.00	
10" pipe culvert.....	512 "		594.94	619.94
Catchbasins				
New	8	\$	784.00	
Reset	6		220.00	
Storm water inlet.....	4		300.00	1,304.00
Grubbing, Resoiling, Etc.				1,379.08
Concrete Coping	2,598 lin. ft.			2,047.40
Total.....				\$ 28,889.54

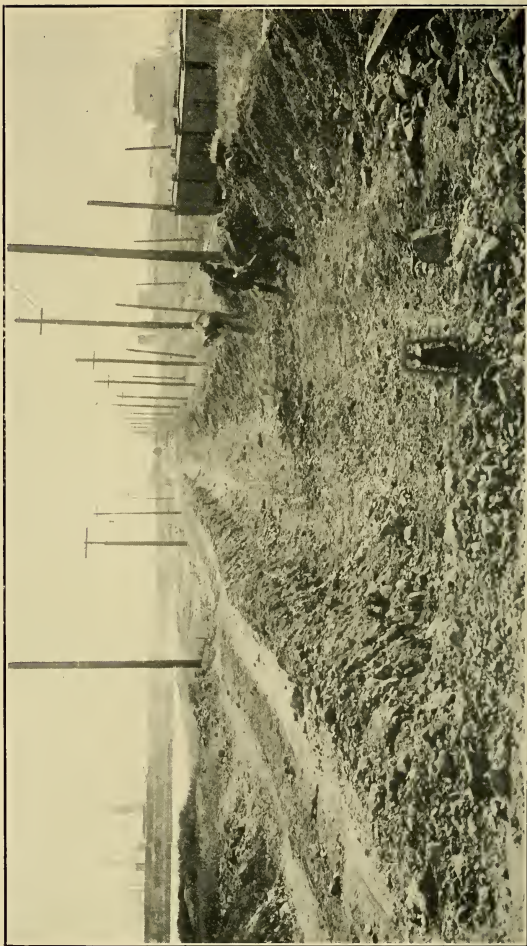
Summary

Public	\$338,234.99
Private	181,678.53
City Pay	28,889.54
Total	\$548,603.06

Under the supervision of the City Engineer, Assistant Engineer James M. Owens has charge of the work of planning street and boulevard improvements.



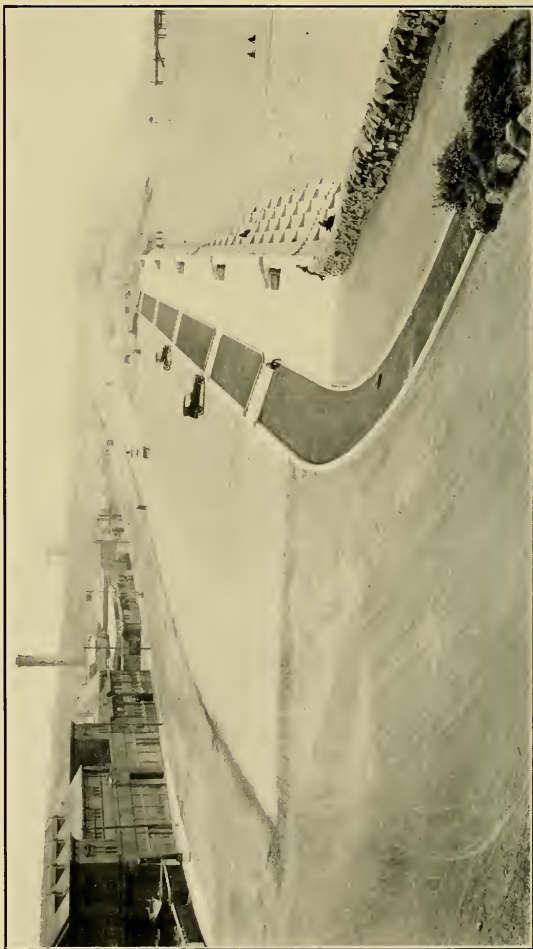
Army Street and Potrero Avenue. Breaking ground for track construction.



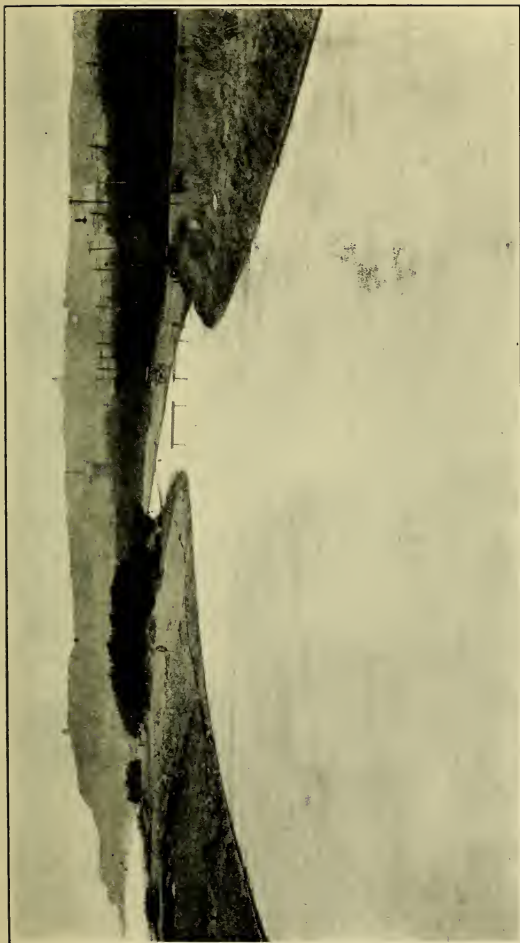
Army Street east from Pennsylvania Avenue. Grading for track construction.



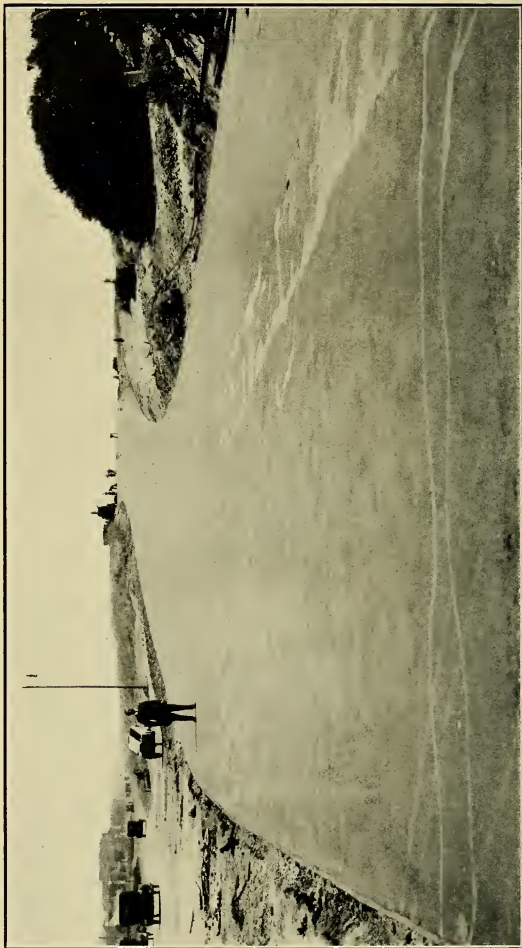
Great Highway Esplanade south before improvement.



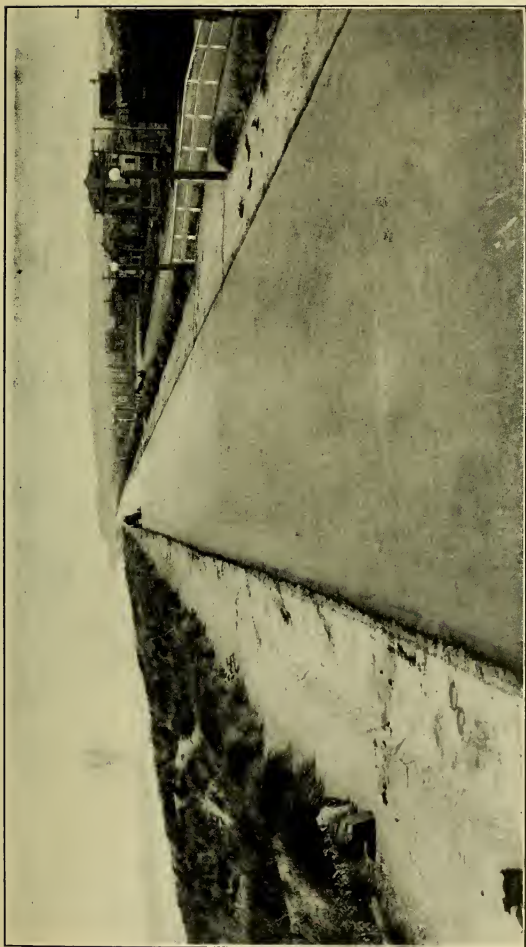
Great Highway Esplanade south after improvement.



Great Highway. Concrete base looking north from Lincoln Way.



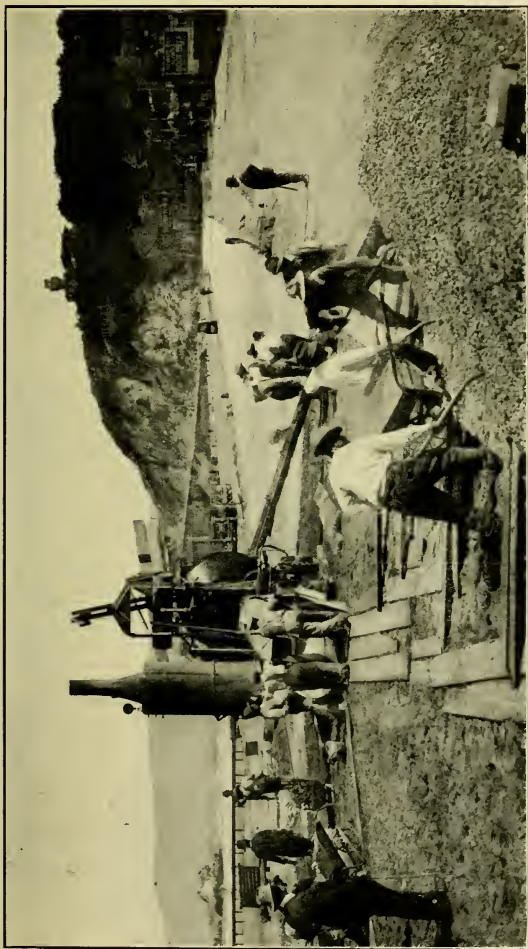
Great Highway. Completed pavement looking south from Lincoln Way.



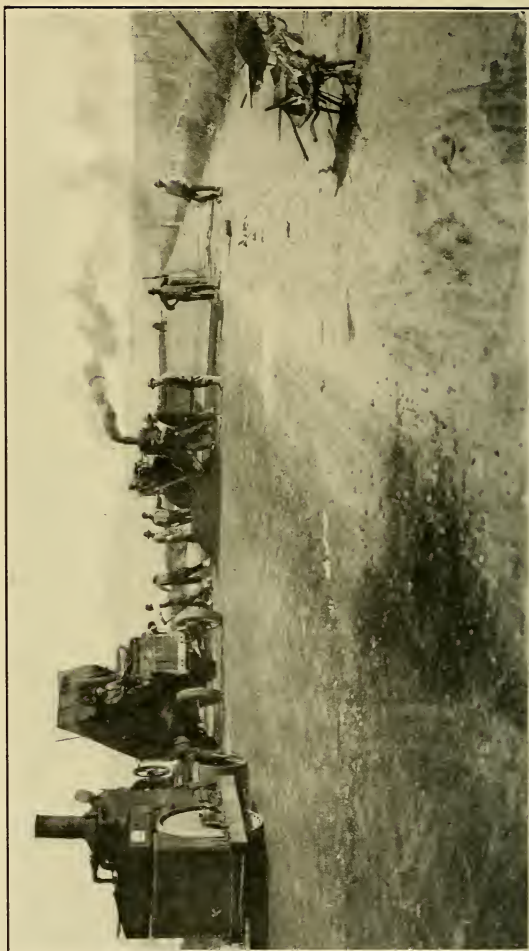
Great Highway looking north from Sloat Boulevard. Completed pavement.



Great Highway looking north from Sloat Boulevard before improvement.



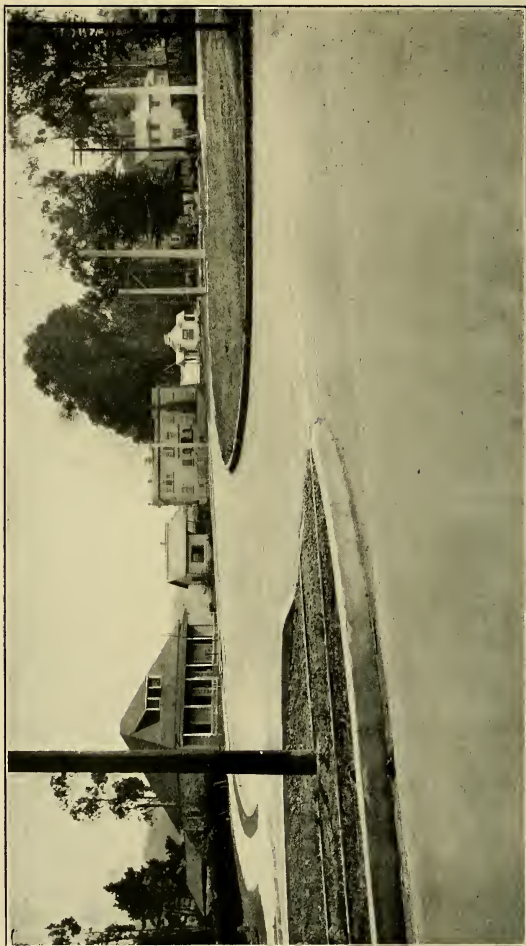
Great Highway north from Fulton Street. Laying concrete base.



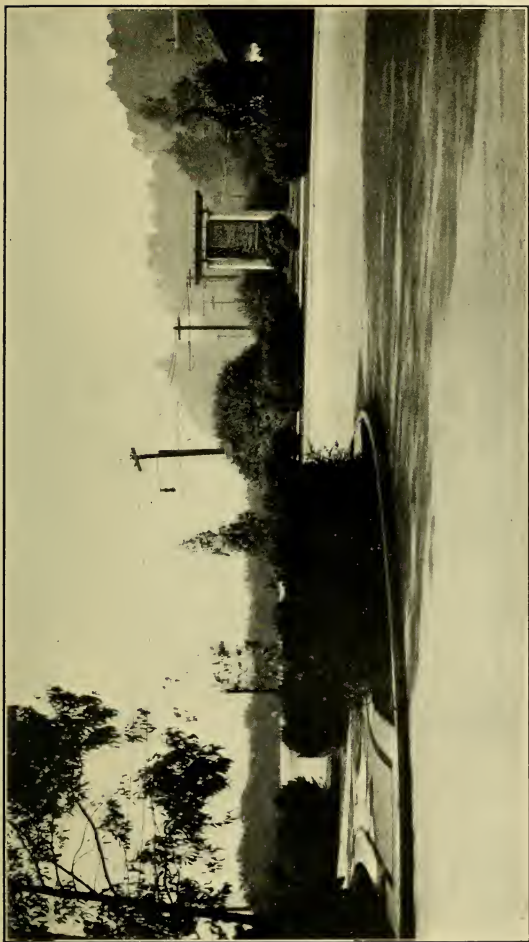
Great Highway north from Sloat Boulevard. Paint Binder and Topeka Top.



St. Francis Circle and Sloat Boulevard. Completed pavement.



St. Francis Circle. Completed pavement at Circle.



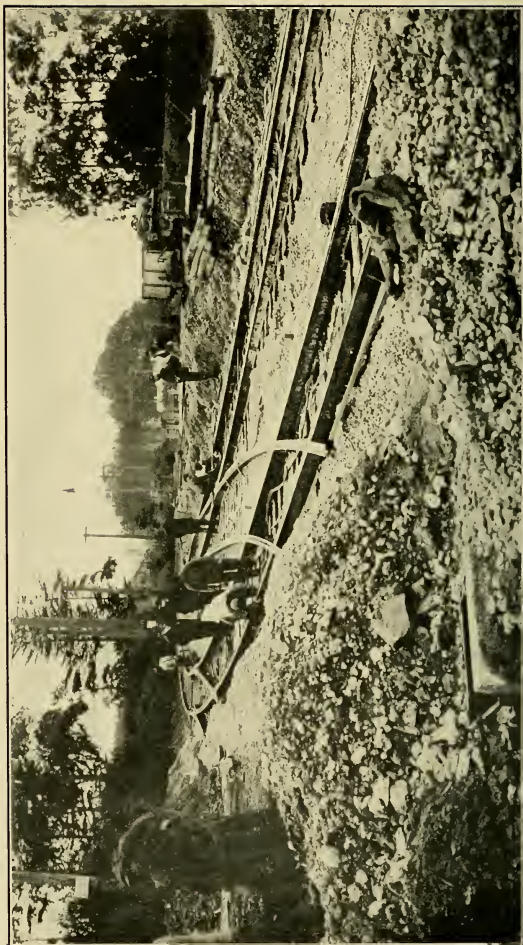
St. Francis Circle looking west before improvement.



St. Francis Circle looking west after improvement.



St. Francis Circle. Showing grading through center.



Showing Special Work. Municipal and U. R. R. tracks at Sloat Boulevard and southerly end of Circle.

SEWER SYSTEM

During the fiscal year 1918-19 no great amount of work was undertaken in the way of extensions and improvements to the main sewer system. The concentration of national effort toward the successful prosecution of the war operated to delay such improvements as were not absolutely war essentials. The participation of labor in war industries and the necessity for the investment of large sums of money in Federal war loans were paramount, thus bringing municipal betterments almost to a standstill.

There were a few projects whose construction could not be deferred, owing to conditions demanding immediate attention. The work undertaken was as follows:

Guttenberg Street Sewer:

This sewer runs along Guttenberg street from Mission street to the first angle point southerly from Morse street, where it intercepts the waters of a small creek, which, in the winter, caused considerable damage to property located between Mission street and Islais creek.

The contract called for the construction of 670 feet of 2-foot by 3-foot reinforced concrete sewer and 191 feet of 15-inch pipe sewer, and was let to J. C. Tormey on July 22, 1918. The contract was completed on November 8, 1918. This sewer cost \$5132.50.

Orizaba Street Sewer:

In order to provide sewerage facilities for the growing district lying south of the Southern Pacific Railway and west of San Jose avenue, a contract was let to the Moran Improvement Company, Inc., on October 11, 1918, for the construction of a pipe sewer from the sewer in Orizaba street at Palmetto avenue, east on Palmetto avenue to an acquired right of way, south to De Long avenue, and west on De Long avenue to Goethe street. The contract called for the construction of 815 feet of 18-inch pipe sewer and 164 feet of 15-inch pipe sewer, and was accepted on October 23, 1918. The cost was \$3525.99.

Euclid Avenue Sewer:

This work is a step in the solution of a larger problem, which affects the entire main sewer system of the Richmond District east of Twenty-third avenue.

In 1893, when the Richmond District was sparsely populated, the city designed the main sewer system of the district on the basis of a normal rate of growth, and assuming a storm water runoff factor of about 30 per cent. The sewers were constructed in 1894 with the main outlet at the shore at Twenty-seventh avenue. A large main extended east on Lake street to Tenth avenue, south on Tenth avenue to California street and east on California street and Cornwall street to Arguello boulevard, with a branch from Fourteenth avenue and Lake street, south to Geary street and east on Geary street to Parker avenue.

The expected rate of growth in the district has been greatly exceeded and the area served by the sewer mains has now been well covered with roofs and impervious pavements, resulting in an average storm water runoff factor in excess of 55 per cent. The result of this rapid growth is that the main sewers are overtaxed as to capacity and require enlargement throughout the system. The construction of the Twenty-second avenue relief for Lake street, as noted in my last annual report, has operated this year satisfactorily as a part of the permanent enlargement, and the Euclid avenue sewer will furnish permanent relief for the easterly portion of the district.

There are other sections which must be attended to in the near future, but these depend upon the results of a thorough and systematic study of conditions, which is now being conducted by this office.

The Euclid avenue sewer extends from Cornwall street and Second avenue easterly along Cornwall street to Arguello boulevard, southerly to Euclid avenue and easterly to Palm avenue. The contract calls for the construction of 700 feet of 2-foot by 3-foot reinforced concrete sewer and 353 feet of 2-foot 6-inch by 3-foot 9-inch reinforced con-

crete sewer, and was let to Hickey & Harmon on May 28, 1919. Before the new structures could be built it was necessary to tear out about 300 feet of the original brick sewer in Cornwall street. The condition of the brick work in the original sewer was found to be excellent, and in order to utilize the old structure as far as possible, a change was made in the design of the new sewer, resulting in the retention of the original brick invert and the construction of new sides and top of reinforced concrete.

The work is about 30 per cent completed, and is progressing satisfactorily.

Miscellaneous Contracts:

Contract to furnish and install a portable bracket elevator for cleaning the sand chamber in the Treat avenue sewer at Seventeenth street and Treat avenue; let to Meese & Gottfried Co., on July 12, 1918, for \$1970. The elevator has been placed in service, and with it 28 cubic yards of deposit can be removed per day, where, under the old hand method, 4 cubic yards was the average daily removal.

Contract to furnish and install an 8-inch vertical centrifugal pump and motor for handling sewage at the Sewage Pumping Station at Commercial and Drumm streets; awarded to J. E. O'Meara on October 4, 1918, for \$2883. The Commercial Street Pumping Station was originally provided with two vertical centrifugal pumps and motors. These pumps have been operated almost continuously to capacity and were not capable of handling properly the increased load due to new buildings constructed in the tributary district. It was therefore necessary to provide additional pumping facilities in order to handle the increase and also to guard against interruption of service in case of breakdown of either of the original pumping units.

This contract was delayed by circumstances beyond the control of the contractor, but is now about completed.

Future Work:

Plans are completed for the extension of the concrete sewer in Euclid avenue from Palm avenue to Jordan avenue, and for the construction of 18-inch and 15-inch pipe sewer from Jordan avenue to Parker avenue. The cost of this work is estimated at \$7600. This contract is another link in the Richmond Sewer System and will be let in the next three months.

Plans are also completed for the enlargement of the sewer which crosses the Presidio Military Reservation from Pacific avenue and Locust street to Lyon and Union streets. The contract will call for the construction of about 1350 feet of a 2-foot 6-inch by 3-foot 9-inch reinforced concrete sewer, and will connect with the existing 4-foot by 6-foot tunnel in the reservation. The existing sewer to be replaced is an 18-inch pipe, which has not sufficient capacity to handle the flow during the rainy season. The cost of the new work is estimated at \$12,000.

The establishment of the Aquatic Park at the foot of Van Ness avenue and the completion of the preliminary work towards the securing of proper conditions for the enjoyment of the park point to the necessity of some work being done to divert to other points of outfall the sewage which is now discharged into the bay in the vicinity of Van Ness avenue. This problem is being studied for early solution.

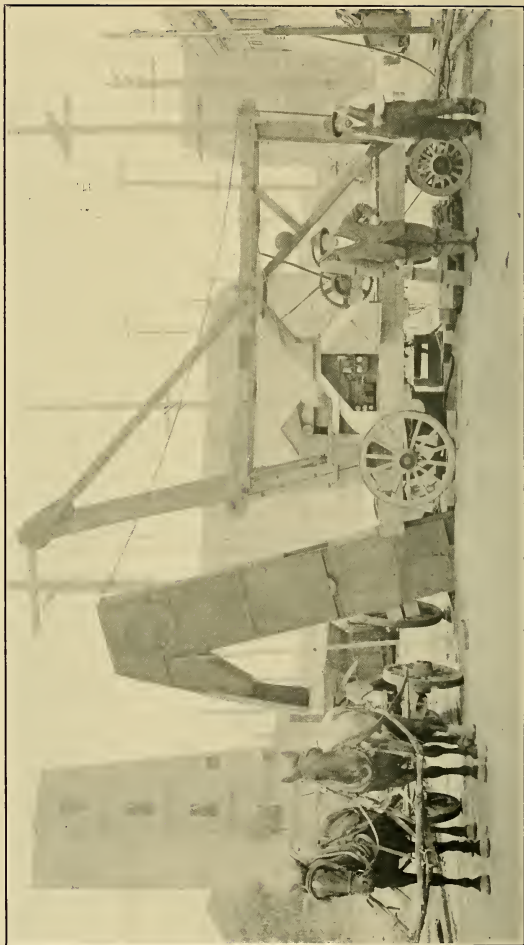
Electricity in the Sewer Department:

In the past year the City Engineer's office has supervised the operation of the electrically driven sewage pumps at Forty-eighth avenue and Fulton street and at 81 Commercial street. At the former place there are two 200 horse-power motors, automatically controlled. At the latter place there are three pumps, each driven by a 10 horse-power motor, which also operate automatically during the larger part of the time.

To expedite the cleaning of the settling chamber of the Division street sewer a specially designed electrically oper-

ated portable elevator has been maunfactured and placed in service.

For a number of years the Sewer Department has been experiencing difficulty with gasoline, gas and other explosive vapors in the sewers. In order to avoid as far as possible injury to men working in the sewers due to ignition of such vapors by open flames, a small portable storage battery light has been designed and manufactured for the use of the sewer repairers. Some twenty-five of these lights are now in use. Small motor generator sets have been provided for charging these batteries.



Portable Elevator for use in cleaning Sedimentation Chamber in Division Street sewer.



Interior view of Sewage Pumping Station at Commercial and Drumm Streets.

HETCH HETCHY WATER SUPPLY

The work of design and construction of the Hetch Hetchy Water Supply works has been prosecuted throughout the fiscal year as fast as possible with the limited funds available. War conditions interfered more seriously with this work than with other municipal improvements in the city, because of the greater difficulty of financing large units of construction, and also because labor of the type required for our work in the mountains was exceedingly difficult to obtain. As described later in this report, before expending money on this project it was necessary to secure the approval of the Capital Issues Committee and the War Industries Board.

Headquarters Organization:

The Hetch Hetchy work is carried on under the direct supervision of City Engineer M. M. O'Shaughnessy, as Chief Engineer of the project. He dictates all matters of policy, directs the work of design and construction, and keeps in close personal touch with the construction work by frequent visits to the field of operations.

Engineering and Clerical Staff:

The Hetch Hetchy Water Supply organization forms a distinct branch of the City Engineer's office. It includes engineers and draftsmen, devoting their entire time to the design of the numerous structures, such as dams, aqueducts, power houses, regulating and diverting works, and to the preparation of plans and specifications for the project. Other members of the City Engineer's staff devote part of their time to the Hetch Hetchy work and the balance to other assignments in the Bureau of Engineering. For work of a highly specialized nature, consulting engineers of long special experience are sometimes engaged. There is also a clerical staff handling requisitions, payrolls, bills, contract payments, etc.

HEADQUARTERS OFFICE ENGINEERING.

The principal pieces of work accomplished along the line of engineering design during the fiscal year were the preparation of plans and specifications for the Hetch Hetchy dam and the completion of a study on the general design of the Hetch Hetchy aqueduct from Moccasin creek to San Francisco.

Hetch Hetchy Dam:

Final plans and specifications were prepared for the construction of the Hetch Hetchy dam, and bids on the work were opened July 30, 1919. The dam is to be of the arched gravity type, with a maximum height above foundations of about 300 feet. The spillway lip of first unit will be at elevation 3720, which is 220 feet above the natural water surface elevation in the river at the dam site during the season of low flow. The principal items of the work are estimated as follows:

Excavation below stream level.....	77,000 cu. yds.
Excavation above stream level.....	60,500 “
Cyclopean masonry	300,200 “
Concrete not included in Cyclopean masonry.....	69,500 “

The dam is to have a siphon spillway. The advantage of this type over the ordinary overflow spillway arrangement is that, in a dam of a given total height, the spillway level can be raised several feet higher than would be possible with a plain overflow spillway having equal capacity for the discharge of flood flows. With the siphon arrangement the head effective to discharge flood flows will be considerably greater, due to the properties of the siphon, than the mere height of the water surface above the crest of the siphon.

The capacity of the reservoir below elevation 3720 is sixty-six billion gallons. In the ultimate utilization of the Hetch Hetchy Reservoir the high water level is to be eighty feet higher than is planned for the present dam, and the capacity of the reservoir will be 112 billion gallons.

When the rate of consumption of water requires additional storage capacity, the height of the dam will be increased, concrete being added on the down stream side of the dam at the same time, in order to give the additional mass necessary to resist the greater pressure of the water. The foundations required under the present specifications are of the full size necessary for the ultimate dam. It would, of course, be cheaper to construct the entire dam to the ultimate height at once, but the dam as at present planned is ample for present needs, and by deferring its completion to some future time the burden on the taxpayers for construction becomes less onerous, and also the money saved can be devoted to other necessary parts of our construction work, which is a very important consideration in these times when financing is so difficult.

Under the supervision of the City Engineer, the dam was designed by R. P. McIntosh, assisted by R. J. Wood, and the specifications were prepared by Leslie W. Stocker.

Outlet System of the Hetch Hetchy Dam:

The method by which water is to be released from the reservoir required careful study. It is necessary to be able at any time to release any quantity of water of the natural daily flow of the Tuolumne river up to 3000 second-feet. Experience with other large dams has demonstrated that great care must be taken in designing the outlet structures and conduits, in order that the water released shall flow smoothly through the outlets, and not cause surges or vibrations that might ultimately wreck the gates or valves controlling the flow. Mr. Frank Teichman, formerly of the Reclamation Service, an expert on outlet systems, was employed as consulting engineer in the design of the Hetch Hetchy dam outlet system.

The outlet conduits will be twelve in number; six of them, each 5 feet in diameter, to discharge the water which the city releases under certain conditions of stream flow for the use of the irrigation districts in the lower reaches of the Tuolumne river, and the other six, each 3 feet

6 inches in diameter, to release the water which will be delivered to San Francisco and the bay region for domestic use. This double system of outlets is necessary primarily because in the ultimate development of the Hetch Hetchy project the water released through the smaller outlets will go immediately into an aqueduct tunnel, after passing the valves, while the water for irrigation may flow directly down the bed of the river. The double system also will facilitate the measurement and apportionment of the flow to the irrigation districts. Each outlet will be provided with a balanced valve of the needle type, by means of which the quantity of water flowing through the outlet will be regulated. These valves will be operated by means of hydraulic pressure and will be balanced—that is, held in place by equal or nearly equal hydraulic pressures acting against opposite sides of the valve. A very ingenious and at the same time very simple device has been designed for the purpose of controlling manually the operation of the valves and maintaining the hydraulic balance of pressures so that the position of the valves will not be altered by changes in the pressure conditions. At the entrance to the conduit leading to each valve there will be a slide gate, also hydraulically operated. The function of this gate will be to close the conduit if for any reason the balanced valve should require inspection or repairs. The slide gates will not be used to regulate the flow, but will normally be either fully open or fully closed. Regulation will be accomplished entirely by means of the balanced valves.

The furnishing of the valves for the outlet system is not included in the contract for constructing the dam. Several separate contracts will be let for furnishing and delivering these valves. It is provided, however, in the contract for constructing the dam that the contractor shall install the valves, as well as any other metal work which the city may furnish to him, at three cents per pound.

Complete plans have been prepared for the valves, slide gates and pipes comprised in the outlet system, and specifications are now in course of preparation.

Hetch Hetchy Aqueduct Design:

A study of the general design of the Hetch Hetchy Aqueduct from Moccasin creek to San Francisco was completed during the fiscal year. This study was made to determine definite capacities and sizes for the portion of the aqueduct in question, the Mountain Division, east of Moccasin creek, having received first consideration on account of its earlier construction for power development purposes. A number of tentative designs for the aqueduct had previously been prepared, but owing partly to the rapid advance in engineering art on water works design and partly to the great expansion of the capacity of the Hetch Hetchy System as compared with the old plans, it was necessary to take almost an entirely fresh start.

The maximum hydrostatic head in any great length of the San Joaquin pipe line will be 535 feet, and in the bay crossing pipe line 365 feet.

The plans developed in this study may be departed from to some extent when the detailed design is taken up, but such changes probably will not be large or radical in character.

Amazon Receiving Reservoir:

In connection with the aqueduct study it was necessary to fix upon a definite point at which the water should be delivered from the Hetch Hetchy Aqueduct in San Francisco. Considerations of economy in the construction of the aqueduct called for a low point of delivery so that the aqueduct itself may be made as small as possible, but the lower the point of delivery the more pumping is necessary to raise the distribution of water to the higher levels in the city. The elevation at which these two considerations balance was found to be somewhere in the neighborhood of elevation 212 feet above city base. Certain other considerations arise, however, which make it desirable to depart somewhat from this economic balance. One of the chief considerations was the availability of a site for a large

reservoir. An excellent reservoir site was located in the saddle between Mission street and Visitacion Valley, the site lying partly in the Crocker-Amazon subdivision and partly in the Somsps tract. This site has been definitely adopted as the location of the large receiving reservoir for Hetch Hetchy water, and about one-third of the necessary land has already been acquired by the city. The high water surface elevation in this reservoir is to be 240 feet above city datum.

Studies for the design of the aqueduct were made by Leslie W. Stocker.

Priest Dam:

Surveys have been made and mapped and test pits have been dug at the site of the Priest Dam, and plans for the earth fill dam with concrete core are in course of preparation. This dam will form a reservoir which will break the aqueduct line just above the Moccasin creek power house. The capacity of the reservoir will be 2500 acre feet or 800,000,000 gallons. Its function will be to regulate the flow of the water, which it will receive at a constant rate throughout the day and discharge at a varying rate according to the fluctuating demand for power from the Moccasin creek power plant.

Dumbarton Crossing:

The Hetch Hetchy Aqueduct line crosses the southerly part of San Francisco bay between Dumbarton Point and Ravenswood Point a few hundred feet south of the Southern Pacific Railway bridge.

After compiling all available information as to the nature of the bottom, it was found desirable to obtain still more information before definitely designing the aqueduct structure at this point. Specifications were therefore prepared for test holes to be sunk at short intervals along the line in the bay and in the marsh at each side. No contract has as yet been let for this work.

Negotiations With War Industries Board:

Authorized by a resolution from the Board of Supervisors of October 15, 1918, the City Engineer proceeded to Washington for the purpose of obtaining if possible the approval and aid of the Capital Issues Committee and other branches of the national government for the issuance and sale of sufficient water bonds for the city of San Francisco to complete the Mountain Division of the Hetch Hetchy project. The City Engineer was authorized to present to said committee and other branches of the national government, on behalf of the city of San Francisco, the necessary formal applications asking for such approval and aid.

Previous to this trip, from Friday, September 27th, to Monday, September 30, 1918, Major George F. Sever, United States Army Engineer, accompanied the City Engineer over the Hetch Hetchy project for an examination and report on same. Major Sever was assigned by the War Industries Board in Washington to review all hydro-electric construction on the Pacific Coast and make recommendations in the order of merit of construction activities which should not be interrupted either by draft of employees or by failure to secure adequate money, and in a report to the City Engineer on October 5, 1918, Major Sever stated: "I would deem it justifiable to consider the electric power on the Hetch Hetchy project a necessary item to be maintained during the war."

The city's funds were very nearly exhausted and the local district committee on Capital Issues practically notified the Treasurer that no more city bonds were to be sold, the result of which would cause the cessation of work on the Hetch Hetchy project.

The City Engineer, on his arrival in Washington, interceded with Senator Phelan to secure his aid with the War Industries Board and Capital Issues Committee so that the city's activities would not be interrupted by the war exigencies. On Saturday, the 19th of October, the first interview for the purpose of making a presentation of the city's

case was had with Mr. Baruch, chairman of the War Industries Board, and he received the City Engineer and City Clerk Dunnigan, who accompanied him, most kindly and promised his cordial assistance so far as possible. On the afternoon of the 22d of October a further interview was had with the Capital Issues Committee, Mr. Holman presiding, with Mr. Cates, Mr. Drum, several other members of the Board, Senator Phelan and Clerk Dunnigan. Approval was desired for the sale of \$1,500,000 of bonds, but they suggested allowing the sum of \$1,000,000 after they had a conference with the local committee in San Francisco by wire. It was explained to the committee that \$6,000,000 had so far been expended on the project—\$2,000,000 on lands and water rights, \$2,000,000 on railways and transportation, and \$2,000,000 on construction work of the project, including Lake Eleanor Dam, the power plant, construction camps, etc. They took the subject of our application under advisement and communicated with the local District Committee on Capital Issues, of which Mr. John Perrin was chairman, to secure its approval. Notwithstanding the adverse report of the latter committee, which was written without knowledge of the needs of the city or the facts of the case, the Washington Board approved the city's application, and we were enabled to proceed with the disposal of \$1,000,000 of our bonds at an early date, thus providing for continuous construction of our Mountain Division.

The City Engineer returned to San Francisco on October 30, 1918, after accomplishing this mission.

FIELD OPERATIONS.

In continuance of the policy of previous years, no construction work has been undertaken west of Moccasin creek, except on the Hetch Hetchy Railroad. The funds available are so limited that the work must be concentrated upon the construction of the units whose completion will bring the earliest tangible benefits to the city. These units

are the Hetch Hetchy Dam, the aqueduct extending from Early Intake to Moccasin creek, and the Moccasin creek power plant.

Field Headquarters Organization:

The headquarters of the city's construction operations in the Sierra Nevadas is in the town of Groveland, Tuolumne county. All work is under the direction of the construction engineer. An engineering and clerical staff is located at this point to handle the work of estimating, mapping surveys, keeping cost accounts, making up payrolls, paying the men employed by the city, ordering supplies, other clerical work, train dispatching on the Hetch Hetchy Railroad and many other details which can be more efficiently handled in the field close to the construction work than in the city office.

C. R. Rankin was construction engineer to May 10, 1919, at which time he was transferred temporarily to the city office. N. A. Eckart was placed in charge at Groveland to act as construction engineer until Mr. Rankin's return. L. B. Cheminant is assistant to the construction engineer, and Willis O'Brien is paymaster and has charge of the clerical force.

Employees' Quarters at Groveland:

On account of the increased proportion of married men among the personnel of the engineering and clerical force located at Groveland, it was found necessary to provide additional accommodations for families. Three 4-room cottages have been erected and nine more are under construction. A large residence building, containing a living room, dining room, kitchen, and ten bedrooms, is fully occupied. This building is intended for use by single men, but pending the completion of the cottages some of the rooms are being used by married employees. Attendants are employed to take care of the building and to cook and serve meals for the occupants. Rentals are charged for the cottages and rooms, and employees taking their meals at the living quar-

ters are charged for board, so that the establishment is self-supporting.

Medical Attention and Hospital Service:

In last year's report mention was made of a contract under which the city's hospital building at Groveland was to be equipped and medical and surgical services furnished by Dr. E. T. Gould of Sonora. After several months' operation under this contract it was cancelled at the request of Dr. Gould. The hospital has now been fully equipped by the city, and all members of the hospital staff, including the physician and surgeon in charge, are in the direct employ of the city. Two nurses, for day and night duty, respectively, are regularly employed.

The hospital building is a two-story structure, equipped with steam heating plant and electricity. On the lower floor are located one ward, two bedrooms, bath, dining room, kitchen and nurses' supply room. The second floor has an operating room, sterilizing room, ward, X-ray room, two bedrooms and two bath rooms. The hospital equipment is first class and complete. The establishment was examined in May, 1919, by Dr. Wm. C. Hassler, Health Officer of San Francisco, who was thoroughly satisfied with the hospital arrangements and equipment.

Every applicant for employment on the Hetch Hetchy work is examined physically and medically before being accepted. To facilitate such examinations a small office building was built adjacent to the hospital.

All camps on the work are in direct connection by telephone with the hospital, so that accidents on day or night shifts may be promptly reported. Attention can be given quickly or patients transported to the hospital by track automobile. A branch hospital will be opened at Hetch Hetchy Dam site, when construction at that point begins on a large scale. The building for this purpose is already erected.

Great care is exercised to guard against accidents on the work, and foremen are required to take every pre-

caution for the safety of their men. During the five years' construction work has been carried on, but two fatalities have occurred in the forces employed directly by the city, each caused by sliding rock on grading work.

The establishing of a city operated hospital with a medical staff has been of great benefit to the work, especially during the recent influenza epidemic. Every city employee is charged 50 cents per month as a hospital contribution, and by providing medical attention and hospital service the city gains the benefit of a reduced insurance rate with the State Compensation Insurance Fund. When contract work is begun, the hospital service will be extended to the contractors' employees, the contractors being charged \$1.00 per month per man. These charges and reduced insurance rates are sufficient to make the service self-supporting.

Storehouse at Groveland:

A general storehouse and central warehouse has been erected at Groveland, from which all supplies used on the work will be issued. Regular stocks of provisions and building materials will be handled through the storehouse. Tools, many kinds of construction equipment and replacement parts for construction machinery are carried in stock. This system permits purchasing and storing of stocks of provisions at the proper seasons when the prices are lowest, and assures quick delivery at the various camps.

In connection with the storehouse, an equipment shed has been erected for storage of all equipment not in use at the various works. Here, when necessary, the equipment is overhauled, repaired, painted and placed in working shape ready for the next job. To facilitate this work the equipment shed was built in close proximity to the machine shop and our repair shop.

Work at Hetch Hetchy Dam Site:

To facilitate unwatering the foundation of the Hetch Hetchy dam, the removal of a gravel bar and croppings of

bedrock for a distance of one-half mile below the dam site was undertaken, beginning in August, 1918. Derricks, donkey engines and other equipment were moved from the completed Eleanor Dam, and barges for handling equipment and supplies by water were built. During the low water season, the water of the Tuolumne river was diverted into a flume past the location of this work, so that activities could be conducted without serious interference due to the presence of water. The ledge rock and the larger boulders were blasted and the large pieces removed from the channel by means of derricks. The gravel bars were found to be more or less cemented, requiring blasting to loosen up the material. The excavation was made in benches of about five feet in depth.

As the high water period approached, more attention was concentrated upon the mere loosening of the material, and less upon the actual removal of the loosened material from the channel, with the idea that the spring floods would scour out the loosened material and carry it down stream, so that the labor of actual handling would be made unnecessary. This system worked out very well.

In order to loosen up rocks which were jammed in position, and to start rocks which might not have been picked up by the current but which rolled along the bottom readily after being started, a large drag hook was rigged and moved along the bottom of the channel by means of a donkey engine.

The diversion tunnel, on a 2 per cent grade, by-passing the site of the dam, is being increased in size from twenty feet diameter to an oval shape twenty-five feet wide by twenty-three feet high, and continued down stream for a distance of about 600 feet. This additional tunnel will reduce the depth of excavation in a portion of the channel change, and will simplify the construction of the necessary cut-off wall, or cofferdam, on the down stream side of the dam site, since the bedrock rises in a down stream, parallel direction.

Additional buildings were constructed at Dam Site camp to accommodate the employees on this work.

Lake Eleanor Dam:

The dam across the outlet of Lake Eleanor was completed during the year, and the reservoir behind the dam has already been put to use for storage of water in connection with the Lower Cherry Power Development. The amount of storage required in this connection is not large, and the reservoir will be filled each year comparatively early in the flood season. One of the photographs accompanying this report shows the overflow from the spillway during the high water season of 1919.

The flow line is at elevation 4660, and the capacity of the reservoir is over 26,700 acre feet, or about 8,700,000,000 gallons. For comparison, it may be noted that the capacity of the Spring Valley Water Company's San Andreas reservoir, west of Millbrae and north of Crystal Springs reservoir, is 6,230,000⁰⁰⁰ gallons.

The Lake Eleanor dam is located at the site of a future higher dam and will form a part of the future dam. It is 1260 feet in length, with a maximum height of 70 feet above stream bed, and contains 11,640 cubic yards of concrete and 262,000 pounds of reinforcing steel. It is of the buttressed arch type, with twenty arches, each of forty feet span, the remaining 460 feet of length being a low gravity wall. Two hundred feet of the gravity wall forms the spillway. The entire length of the dam is traversed by a reinforced concrete roadway. All work in connection with the structure was done by day labor.

Aqueduct Tunnel:

Work on the eighteen-mile aqueduct tunnel from Early Intake to Priest Portal (known as the Mountain Division of the Hetch Hetchy Aqueduct) has been carried on continuously by day labor during the past year. Camps have been established at Early Intake Portal, South Fork Portal, Big Creek shaft, Second Garrotte shaft and Priest Portal.

These points afford working faces on the longest units of the tunnel aqueduct.

Tunnel plants have been installed at the working faces, embodying the latest ideas in mining machinery. Standard equipment was selected with the idea of facilitating repairs and minimizing the stock of repair parts. This equipment includes motor driven Laidlaw feather-valve compressors, Root rotary blowers with 20-inch air pipe, storage battery locomotives with charging apparatus, side dump roller bearing tunnel cars, improved Water-Leyner, Sullivan and Waugh rock drills, and air-driven drill sharpeners, with grinders, punches, etc.

The track used in the tunnels is of 30-pound "T" rails, laid to 24-inch gauge.

A Myers-Whaley mucking machine for loading rock cars has been in use in the Priest heading during the past six months, and has given very satisfactory service. This is in the nature of a new departure or experiment in hard rock tunnels of this size, but with the present shortage of labor it unquestionably increases the rate of progress and decreases the cost of the work.

Double drum motor driven reversible hoists were installed at the shafts and duplicate installation of equipment to handle the two tunnel headings working from the shaft has been made.

An electric motor hoist has been installed at Early Intake tramway and a counterbalanced tramway built at Priest Portal. By means of these tramways, material is delivered from the railroad direct to the tunnel portals.

The Big creek shaft has been completed to its full depth of 646 feet, and the excavation of chambers at and below tunnel grade preparatory to driving the headings is in progress. This shaft has a pumping station, with sump, at a depth of 330 feet. A considerable flow of water was encountered at about the 300-foot level, but moderated at lower levels. The water entering the shaft above the pumping station is intercepted and pumped out from the station.

instead of being allowed to go to the bottom of the shaft to be pumped out, thus effecting a considerable saving of power. A rock pocket, with provision for loading skips by gravity, is being excavated; also a compartment at tunnel grade, in which tunnel construction equipment can be stored and repaired.

The Second Garrotte shaft has been sunk to a depth of 277 feet. Large quantities of water have been encountered, greatly retarding progress. A pumping station with an 8000-gallon sump has been cut at a depth of 260 feet.

On tunnel driving, crews of two shifts have been engaged at Early Intake, South Fork, and Priest Portal. During the year, 5542 feet of tunnel have been driven and trimmed to final section, bringing the total tunnel excavated up to 6379 feet.

All tunnels are excavated to full section in one operation, using rounds of from 18 to 24 holes, with from 70 pounds to 100 pounds of 60 per cent to 80 per cent powder. An advance of about five feet is made per round. The cost of labor and powder for driving these tunnels runs from \$23 to \$30.50 per lineal foot, exclusive of overhead expense, depending upon the character of rock encountered. Most of the rock is granodiorite, schist, or quartzite.

The rock removed from the Priest heading is dumped where it will form part of the down stream toe of the proposed Priest earth fill dam.

Hetch Hetchy Railroad Operation:

The Hetch Hetchy Railroad has been continuously in operation during the fiscal year. Besides hauling machinery and materials for the city's construction work, freight is accepted from private parties for transportation to and from points along the line, although regular train schedules have not been formulated, traffic conditions being still somewhat uncertain. Passengers are carried between Groveland and Damsite on motor trucks, which have been fitted with flanged wheels to run on rails and equipped with seats for passengers. The passenger traffic consists

principally of men traveling to and from the work at the various camps.

The road is a common carrier, its tariffs being officially filed with the California State Railroad Commission. The tariffs are based on the following basic rates: Freight in carload lots, 12.5 cents per ton, mile; freight in less than carload lots, 17.5 cents per ton, mile; passengers, 7.5 cents per passenger-mile. These rates appear high at first glance, but are justified by the high cost of constructing the road in the mountains (more than half the excavation being in solid rock) and the high cost of operating trains over the heavy grades and sharp curvature. A lower rate applies on lumber haul in the westerly direction, in consideration of the comparatively large volume of such haulage and the fact that this is "back haul," providing a load for trains that would otherwise have to be operated with empty cars.

The California Peach Growers' Association has a saw-mill near Mather, with a daily capacity of 50,000 feet board measure, and ships about five carloads of shook material per day over the Hetch Hetchy Railroad. Other and larger mills in the same vicinity are contemplated, which will furnish considerably more "back haul" for the rail line.

Previous to the construction of the Hetch Hetchy Railroad the greater part of the hauling in the region now served by the railroad was done by motor trucks at 40 to 60 cents per ton mile, and during the winter season no heavy hauling was possible. In addition to the great reduction in the cost of freight haul, by the construction of the railroad, we have gained the advantage of continuous service without long interruptions due to heavy snowfall. This permits uninterrupted construction work at all points along the line throughout the year.

Tourist Travel on the Hetch Hetchy Railroad:

An arrangement has been entered into between the city and the Yosemite Park Company under which the company is now operating tours from Yosemite to Hetch Hetchy Damsite. The run of about twenty-five miles from Yosemite

to Mather is made in an ordinary automobile or a motor bus. At Mather the passengers change to a motor bus running on the track and are taken to Damsite, covering nine miles of the Hetch Hetchy Railroad. After seeing the valley and the city's construction work there, they return to Yosemite by the same route. The company furnishes and operates the track buses and pays the city a fixed amount per passenger for the use of the track. It is probable that some time in the future a "triangle service" may be arranged, passengers going to the Yosemite by way of El Portal, leaving Yosemite at the expiration of their stay by buses to Mather, going to Hetch Hetchy and then down to the San Joaquin Valley for their return trip, covering the full length of the Hetch Hetchy Railroad.

Railroad Construction:

Ballasting of the railroad track has been carried on with a small crew intermittently, approximately forty-two miles of track having now been ballasted. A machine shop has been erected at Groveland and equipped with a full complement of tools for handling engine and car repairs, as well as for general machine shop work on all sorts of construction equipment. In connection with this shop, spare parts for all classes of equipment are kept on hand, and an oxy-acetylene welding plant is maintained. Storage for five locomotives is provided, and in addition truck houses, gasoline car barns and car repair shops, with wood working equipment, have been built at Groveland. Additional rolling stock for the railroad has been provided by the purchase of one 86-ton Mikado type locomotive. A caboose has been built in our own shops.

A transfer yard has been built at Groveland, which will be the headquarters for the railroad operation. A concrete oil tank, a water supply system and a locomotive turntable have been installed in the Groveland yard.

At Hetch Hetchy Junction a depot and warehouse building has been erected and a water supply system installed for engine, domestic and fire protection purposes.

Additional siding facilities have been provided at Mather, which is the junction point of the California Peach Growers' Association branch line, and at various other points along the railroad.

Y-tracks have been built at Damsite and Mather for turning gasoline equipment, and additional water supplies have been installed at Hamilton and Grizzly Gulch.

A loopline in the nature of an extension of the railroad has been built at Damsite, involving about a mile of heavy rock grading and a number of masonry walls. This addition will greatly facilitate the handling of material to the dam, and affords a means of turning trains at the terminal of the railroad, as well as facilitating the operation of quarry trains.

Railroad Equipment:

The Hetch Hetchy Railroad now owns rolling stock as follows:

- 1 Baldwin locomotive, Mikado type, 83 tons.
- 2 Heisler geared locomotives, 57 tons and 75 tons.
- 6 box cars, capacity 40,000 pounds.
- 8 flat cars: 1 of 40,000 pounds capacity, 6 of 60,000 pounds, 1 of 80,000 pounds.
- 12 ballast cars: 8 center dump, capacity 80,000 pounds; 4 side dump, capacity 12 cubic yards.
- 2 cabooses.
- 2 maintenance of way cars.
- 3 track trucks.
- 2 track automobiles.
- 6 gasoline speeders.

Lower Cherry Power Development:

The temporary power plant at Early Intake was placed in operation in May, 1918. A transmission line has been constructed, extending from Early Intake along the aqueduct line to Priest Portal, and all of our construction machinery at the various camps where tunnel and shaft work is in progress is being operated by means of electric power. The city's shop equipment at Groveland is electrically driven, and the headquarters establishment is lighted by

electricity, the power for these purposes coming from the Early Intake plant.

The construction of the storage dam at Lake Eleanor, mentioned at greater length elsewhere in this report, was sufficiently advanced to permit closing the outlet gates on June 24, 1918, for the purpose of storing water to be used at the power plant during the dry months of the latter part of the year. The Lake Eleanor reservoir has a capacity of 26,700 acre feet, which, in conjunction with the normal, natural stream flow, is sufficient to operate two units of the power plant throughout the dry period of the year.

The Early Intake plant is equipped with three 1000 K. V. A. generating units. In designing the plant, it was intended that the estimated full load of 2000 K. W. should be carried on two machines, allowing the third unit to be held in reserve, so that a shut-down of one machine need not interfere with construction work by reducing the power output. The power is generated at 2300 volts, 3 phase, 60 cycles, and is stepped up by transformers at the power house to 23,000 volts for transmission along the aqueduct line and to the dam site. It was estimated that the load along the aqueduct, with tunnel construction progressing rapidly in eight to ten headings, would be 800 K. W., that at the dam site being 1200 K. W. during the day time and a smaller amount at night, possibly not over 500 K. W.

The length of the transmission line along the aqueduct is approximately 19 miles, and that of the line under construction from the power house to Damsite is approximately 14 miles. The power house is thus near the load center of the work in the mountains.

As there was no heavy work requiring power under way at the Damsite during the past year, and the work along the aqueduct had not reached a point of maximum demand on the power house, we entered the latter part of the summer of 1918 with a considerable amount of water in storage and a very light load on our power house. The power shortage in California is very serious, as the demand for power has increased much more rapidly than the capa-

city of the generating plants. In fact, no large hydro-electric stations have been constructed for several years, and there are no prospects for the early completion of any new plants. In the meantime, the price of fuel oil has practically doubled, making it very uneconomical, as well as wasteful of natural resources, to burn fuel oil. When it was learned that the city had completed a hydro-electric plant which was not being operated to full capacity, the State Power Administrator immediately issued the following order for the connection of our transmission line with that of the Sierra and San Francisco Power Company, in order that all of our surplus power might be delivered into the network feeding the State.

RAILROAD COMMISSION

of the

State of California

San Francisco

Office of Power Administrator

September 18, 1918.

Mr. M. M. O'Shaughnessy, City Engineer,
City of San Francisco,
City Hall,
San Francisco, California.

Dear Sir:

I am advised that you have available considerable electric energy at the power plant built for the construction of the Hetch Hetchy project. The Sierra and San Francisco Power Company informs me that it has a line which can transmit part or all of this energy.

In view of the present power shortage and the imperative need of making use of all the power available in order to protect shipbuilding and other essential war industries, you should at once make arrangements to turn this power over to the Sierra and San Francisco Power Company so that it will be available for general use.

This letter should be construed as a formal order to that effect.

Yours truly,

H. G. BUTLER,
Power Administrator.

A connecting line 4500 feet in length was built from the end of the city's transmission line to the Sierra Com-

pany's wires, and on September 21, 1918, the city commenced delivering all of its surplus power over this connection to the company.

At first, only one unit of the Early Intake plant was operated, as on account of the late completion of the Lake Eleanor dam the reservoir was only partly filled. As quickly as fall rains made it possible, additional units were put on the line until all three units were operating at full capacity. By the careful handling of the generating equipment it has been possible to overload these three units to such an extent as to send out from the power house 3300 K. W. regularly and almost continuously over long periods of time. Between the time when connection was made to the Sierra Company's lines and July 1, 1919, the city earned from the sale of power a gross income of \$67,528.10, which was not anticipated when the plant was constructed. In order to supply our own power requirements it would have been necessary to operate the power house twenty-four hours a day, so that the generation of the additional power entailed no expense for employing additional men, and only very little other expense. All of the power which we have sold has been power which was not required for our own purposes, and as additional units of the water supply construction work are opened up the amount of power available for sale will be decreased. With the construction work at the height of its progress, we may require all the power which we can produce. In the meantime, however, our plant is not only producing an income, but at the same time is assisting in maintaining the supply of power for all consumers.

The construction of the fourteen-mile transmission line to Damsite is now under way and will be completed in time to furnish power to the contractor who is to build the dam. A transformer substation is to be installed at Damsite to reduce the voltage from 22,000 to 440 volts. All of this work is being done by day labor.

On the existing transmission line, during the past year, there have been but four interruptions of service, two oc-

caused by lightning, the other two by tall trees falling across the line wires. The right of way over which the transmission line is carried was cleared for 100 feet in width, and outside of this clearing all dead trees that might fall onto the line were removed. In the rough country over which this line runs it is very difficult to foresee all of the conditions which might arise. One of the interruptions was caused by a healthy green tree on the hillside above the transmission line becoming so loaded with wet snow as to cause it to break and fall across the transmission line. None of these interruptions has continued for over a few hours, or been attended with any serious or costly results.

Considerable trouble was experienced in keeping satisfactory employees at the power house until individual cottages were built for the married operators, and sleeping quarters for the accommodation of the single operators and the ditch tenders who supervise the aqueduct leading to the power house. Since the completion of these houses we have had no difficulty in retaining our employees.

During the year we have generated at the power house 18,687,400 K. W. H., of which 13,505,621 K. W. H. have been sold, and the remainder, 5,181,779 K. W. H., covers use at the plant, use on the city's work, and line and transformer losses incident to generation and transmission. We have been operating five step-down transformer substations, three at tunnel portals and two at shafts, ranging in capacity from 100 to 300 K. V. A. In addition, each of these substations is equipped with one 10 K. V. A. transformer to supply current for lighting. All of the power current is being used at 440 volts, 3 phase, while lighting current is single phase 110-220 volts. Electricity is the most satisfactory form of power for utilization on the class of work being performed.

With a light winter rainfall, it was as necessary to use stored water from the reservoir until February 3d, since which time, in addition to supplying all of the requirements

at the power house, the runoff from the watershed has filled the reservoir at Lake Eleanor. We are therefore entering the season of 1919 under most favorable conditions as far as power supply is concerned.

Sawmill Operations:

The city's sawmill plant, located at Canyon Ranch, on the Hetch Hetchy Railroad, five miles west of Hetch Hetchy Damsite, was in operation during eight months of the past year. All lumber for the project is manufactured at this plant and hauled by rail to the various divisions on the mountain development. Logging is carried on with donkey engines and chutes over the city's 640-acre tract, which is quite rough ground.

The season's cut from July 1, 1918, to June 30, 1919, amounted to 2,149,000 feet B. M. of lumber. In addition, approximately 500,000 feet B. M. was finished as surfaced tongue-and-groove lumber. The average cost to the city of lumber manufactured at its sawmill is about \$14.00 per thousand feet B. M., including stumpage and amortization charges on the plant.

CONTRACT DATA

Appended to this report is a table, in four sheets, giving information as to all contracts awarded, or prepared but not awarded, up to June 30, 1919.

It happens occasionally that specifications are prepared and bids received but no contract awarded, all bids being rejected. In the case of a contract for construction work, the rejection of all bids may be due to the fact that all were considered excessive by the City Engineer; where the proposed contract is for the furnishing of material, it may be on account of excessive bids or because the material offered was not satisfactory. These conditions have generally resulted in the work being done by day labor, or the material being bought in the open market. In every such case the results have been found satisfactory and economical.

Up to June 30, 1919, fifty-three contracts were awarded, the total of the bid prices being \$2,206,016.72. All but two of these contracts had been completed at that time, the total amount of the final payments being \$2,268,056.10. The discrepancy between the bid prices and the final estimates is, of course, due to extra work, the amount of which could not be accurately foreseen at the time of awarding the contracts.

Contract No. 7—Hetch Hetchy Railroad:

Of all the fifty-one contracts completed to June 30, 1919, the most important was that for the construction of the Hetch Hetchy Railroad. The final estimate on this contract was \$1,574,362.20. The city is now defendant in a suit brought by the contractor, who claims additional payment under some items.

Contract No. 25—Tunnel Aqueduct, Mountain Division:

This is the most important of the contracts which were prepared but not awarded. The City Engineer's estimate of cost was \$6,307,000, and the lowest combination of bids on the three sections into which the contract was capable

of being divided was \$8,989,398.70, 42 per cent over the Engineer's estimate. The discrepancy was to some extent accounted for by the fact that the contractors figured on discounting the bonds. The bids were so greatly in excess of the estimate that the work was taken up by day labor, with very satisfactory results. The progress on the various sections (three headings and two shafts) has already been noted in this report. The cost of the work is fairly comparable with the Engineer's estimate, although prices of labor and material have been increased greatly since the estimate was made. The estimate, of course, included an allowance for probable increased prices.

Contract No. 61—Hetch Hetchy Dam:

Bids on this work were opened July 30, 1919. This is beyond the fiscal year for which the present report applies, but the contract is of such great importance that it is advisable to describe it here.

Two bids were received, one from R. C. Storrie & Co., the firm which held the contract for the construction of the Twin Peaks Tunnel; the other from the Utah Construction Company, which held the first of all the Hetch Hetchy water supply contracts, that for grading the easterly nine miles of the Hetch Hetchy Railroad. The Utah Construction Company's bid was the lower of the two, and the contract was awarded to this company on August 1, 1919, at a total estimated cost of \$5,447,792.50.

A table showing the canvass of bids on this contract is annexed hereto. The contract was awarded on the basis of Bid No. 2, Proposition "A," for the dam with siphon spillway.

HEITCH DELIGHT WATER SUPPLY OF THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA.

CONTRACT NO. 61.

HEITCH DELIGHT DAM AND APPURTENANT WORKS

DATE		TIME		TOTAL		ACTS	
1911	10/1	10:00	11:00	1:00	1	1	1
1911	10/2	10:00	11:00	1:00	1	1	1
1911	10/3	10:00	11:00	1:00	1	1	1
1911	10/4	10:00	11:00	1:00	1	1	1
1911	10/5	10:00	11:00	1:00	1	1	1
1911	10/6	10:00	11:00	1:00	1	1	1
1911	10/7	10:00	11:00	1:00	1	1	1
1911	10/8	10:00	11:00	1:00	1	1	1
1911	10/9	10:00	11:00	1:00	1	1	1
1911	10/10	10:00	11:00	1:00	1	1	1
1911	10/11	10:00	11:00	1:00	1	1	1
1911	10/12	10:00	11:00	1:00	1	1	1
1911	10/13	10:00	11:00	1:00	1	1	1
1911	10/14	10:00	11:00	1:00	1	1	1
1911	10/15	10:00	11:00	1:00	1	1	1
1911	10/16	10:00	11:00	1:00	1	1	1
1911	10/17	10:00	11:00	1:00	1	1	1
1911	10/18	10:00	11:00	1:00	1	1	1
1911	10/19	10:00	11:00	1:00	1	1	1
1911	10/20	10:00	11:00	1:00	1	1	1
1911	10/21	10:00	11:00	1:00	1	1	1
1911	10/22	10:00	11:00	1:00	1	1	1
1911	10/23	10:00	11:00	1:00	1	1	1
1911	10/24	10:00	11:00	1:00	1	1	1
1911	10/25	10:00	11:00	1:00	1	1	1
1911	10/26	10:00	11:00	1:00	1	1	1
1911	10/27	10:00	11:00	1:00	1	1	1
1911	10/28	10:00	11:00	1:00	1	1	1
1911	10/29	10:00	11:00	1:00	1	1	1
1911	10/30	10:00	11:00	1:00	1	1	1
1911	10/31	10:00	11:00	1:00	1	1	1
1911	11/1	10:00	11:00	1:00	1	1	1
1911	11/2	10:00	11:00	1:00	1	1	1
1911	11/3	10:00	11:00	1:00	1	1	1
1911	11/4	10:00	11:00	1:00	1	1	1
1911	11/5	10:00	11:00	1:00	1	1	1
1911	11/6	10:00	11:00	1:00	1	1	1
1911	11/7	10:00	11:00	1:00	1	1	1
1911	11/8	10:00	11:00	1:00	1	1	1
1911	11/9	10:00	11:00	1:00	1	1	1
1911	11/10	10:00	11:00	1:00	1	1	1
1911	11/11	10:00	11:00	1:00	1	1	1
1911	11/12	10:00	11:00	1:00	1	1	1
1911	11/13	10:00	11:00	1:00	1	1	1
1911	11/14	10:00	11:00	1:00	1	1	1
1911	11/15	10:00	11:00	1:00	1	1	1
1911	11/16	10:00	11:00	1:00	1	1	1
1911	11/17	10:00	11:00	1:00	1	1	1
1911	11/18	10:00	11:00	1:00	1	1	1
1911	11/19	10:00	11:00	1:00	1	1	1
1911	11/20	10:00	11:00	1:00	1	1	1
1911	11/21	10:00	11:00	1:00	1	1	1
1911	11/22	10:00	11:00	1:00	1	1	1
1911	11/23	10:00	11:00	1:00	1	1	1
1911	11/24	10:00	11:00	1:00	1	1	1
1911	11/25	10:00	11:00	1:00	1	1	1
1911	11/26	10:00	11:00	1:00	1	1	1
1911	11/27	10:00	11:00	1:00	1	1	1
1911	11/28	10:00	11:00	1:00	1	1	1
1911	11/29	10:00	11:00	1:00	1	1	1
1911	11/30	10:00	11:00	1:00	1	1	1
1911	12/1	10:00	11:00	1:00	1	1	1
1911	12/2	10:00	11:00	1:00	1	1	1
1911	12/3	10:00	11:00	1:00	1	1	1
1911	12/4	10:00	11:00	1:00	1	1	1
1911	12/5	10:00	11:00	1:00	1	1	1
1911	12/6	10:00	11:00	1:00	1	1	1
1911	12/7	10:00	11:00	1:00	1	1	1
1911	12/8	10:00	11:00	1:00	1	1	1
1911	12/9	10:00	11:00	1:00	1	1	1
1911	12/10	10:00	11:00	1:00	1	1	1
1911	12/11	10:00	11:00	1:00	1	1	1
1911	12/12	10:00	11:00	1:00	1	1	1
1911	12/13	10:00	11:00	1:00	1	1	1
1911	12/14	10:00	11:00	1:00	1	1	1
1911	12/15	10:00	11:00	1:00	1	1	1
1911	12/16	10:00	11:00	1:00	1	1	1
1911	12/17	10:00	11:00	1:00	1	1	1
1911	12/18	10:00	11:00	1:00	1	1	1
1911	12/19	10:00	11:00	1:00	1	1	1
1911	12/20	10:00	11:00	1:00	1	1	1
1911	12/21	10:00	11:00	1:00	1	1	1
1911	12/22	10:00	11:00	1:00	1	1	1
1911	12/23	10:00	11:00	1:00	1	1	1
1911	12/24	10:00	11:00	1:00	1	1	1
1911	12/25	10:00	11:00	1:00	1	1	1
1911	12/26	10:00	11:00	1:00	1	1	1
1911	12/27	10:00	11:00	1:00	1	1	1
1911	12/28	10:00	11:00	1:00	1	1	1
1911	12/29	10:00	11:00	1:00	1	1	1
1911	12/30	10:00	11:00	1:00	1	1	1
1911	12/31	10:00	11:00	1:00	1	1	1

CONTRACTS - HITCH HETCHY WATER SUPPLY

[illegible]

7. Continued: (b) Orders to stop the carrier's delivery on
1st of March & 1st of each month thereafter
1st of delivery to be organized later
in the day the board
(c) Continued: (b) Agent charges paid by the city or several
of the wards

Don't you know that I am a poor man?

100

Age Group	Percentage of respondents
18-29	~65%
30-49	~75%
50-69	~85%
70+	~90%

--	--	--

100

10

CONTRACTS - HETCH HETCHY WATER SUPPLY

[illegible]

Figure 1

[illegible]

3. Complete equipment to be delivered immediately
Feb 10 1948
on or before 10am
each month thereafter until all of the apparatus has
been delivered

STATEMENT OF EXPENDITURES ON HETCH HETCHY PROJECT

BUREAU OF ENGINEERING

77

	Fiscal year 1918-19	Previous to July 1, 1918	Total to June 30, 1919
Administration, general office work, plans, etc.....	\$ 60,842.43	\$ 120,907.34	\$ 181,749.77
Legal expense	14,885.66)		
Lands and rights of way.....	9,716.42)	1,914,430.99	1,939,033.07
Investigation of water supply sources, etc.....	.50)	80,409.83	80,410.33
Water rights and protective work.....	23,480.98	104,134.16	127,615.14
Inspection and engineering in the field.....			
Hetch Hetchy Railroad:			
Construction and equipment.....	145,050.74	1,971,177.93	2,116,228.67
Operation	158,086.70	4,172.91	162,259.61
Hetch Hetchy Dam and Reservoir:			
Clearing reservoir site.....	1,178.68	49,362.57	50,541.25
Diversion works	69,586.39	213,575.00	283,161.39
Canyon Ranch sawmill:			
Installation .....	.....	13,000.24	13,000.24
Operation	46,837.24	78,676.90	125,514.14
Timber cut on Government land.....	474.43	4,125.19	4,599.62
Lower Cherry Power Development:			
Aqueduct and power plant construction.....	10,985.17	399,430.76	410,415.93
Transmission line construction.....	13,833.51	92,372.20	106,205.71
Operation	15,584.43	666.05	16,250.48
Lake Eleanor Dam.....	115,430.55	167,599.60	283,030.15
Hetch Hetchy Aqueduct, Mountain Division:			
Tunnel and shaft construction, surveys.....	492,696.68	178,716.26	671,412.94
Early Intake tramway.....	5,918.14	9,670.39	15,588.53

STATEMENT OF EXPENDITURES ON HETCH HETCHY PROJECT—(Continued)

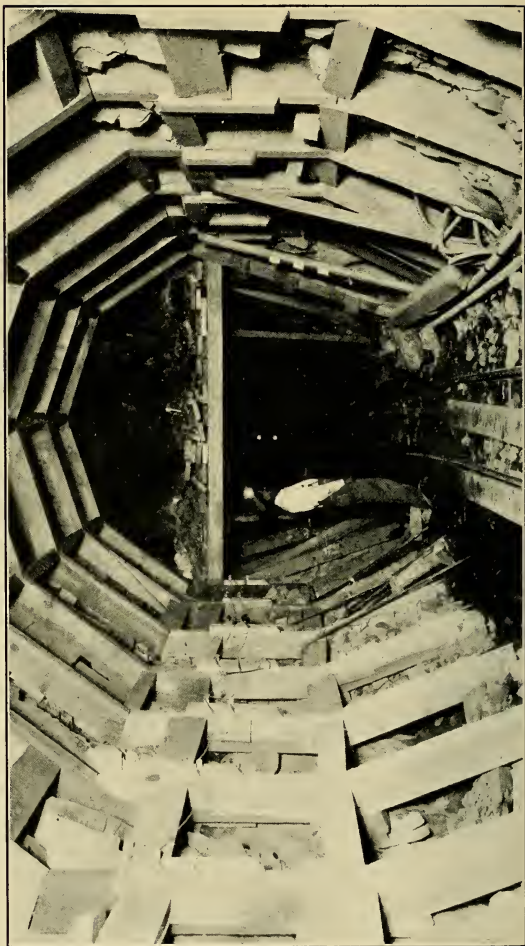
	Fiscal year 1918-19	Previous to July 1, 1918	Total to June 30, 1919
Priest Regulating Reservoir:			
Clearing and exploratory work.....	342.75	2,629.00	2,971.75
Telephone lines.....	7,222.87	4,993.24	12,216.11
Roads, trails and surveys, miscellaneous.....	14,608.42	187,816.67	202,425.09
Hydrography, geology, etc.....	3,467.60	27,056.16	30,523.76
Permanent camps and equipment.....	60,345.05	72,527.99	132,873.04
General construction equipment.....	2,274.87	34,511.70	36,786.57
Hospital buildings and equipment.....	7,372.67	10,131.99	17,504.66
Hospital maintenance.....	9,196.00	2,607.00	11,803.00
State compensation insurance.....	28,926.17	30,765.39	59,691.56
Taxes, rentals, etc.....	5,149.71	.....	5,149.71
Boarding house account.....	143,621.52	21,628.69	165,250.21
U. S. franchise and water rights.....	15,000.00	.....	15,000.00
Revolving fund (continually reimbursed).....	.....	10,000.00	10,000.00
Employees' dwellings, Groveland.....	2,417.78	.....	2,417.78
Machine shop, Groveland.....	23,182.87	.....	23,182.87
Warehouses, Groveland.....	4,064.52	.....	4,064.52
Material and supplies, miscellaneous.....	99,874.16	.....	99,874.16
Golden Rock ditch, operating expenses.....	1,682.85	.....	1,682.85
Amazon Reservoir site, S. F. land purchases.....	75,657.09	.....	75,657.09
San Francisco wells.....	.....	19,906.44	19,906.44
TOTAL EXPENDITURES	\$1,688,995.55	\$5,827,002.59	\$7,515,998.14

STATEMENT OF EXPENDITURES ON HETCH HETCHY
PROJECT—(Continued)

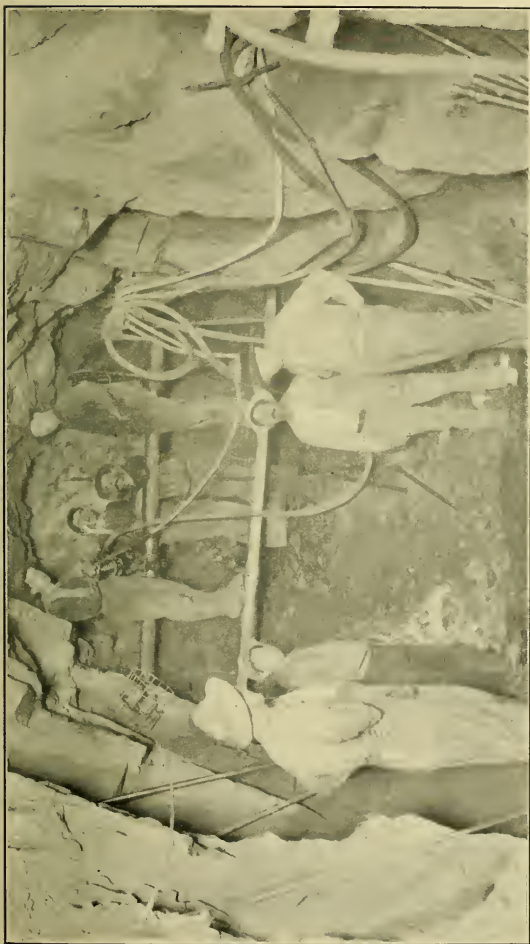
Total expenditures (forward).....\$7,515,998.14

CREDITS:

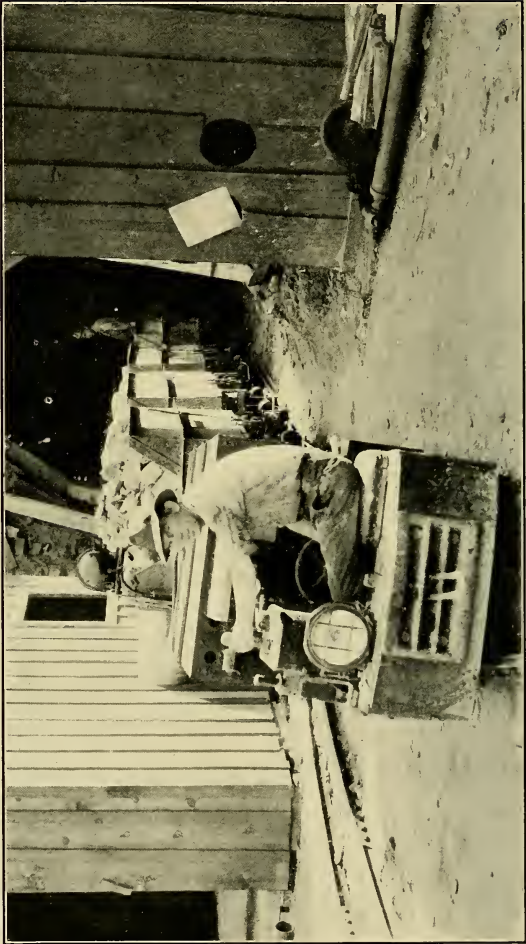
Inspection and engineering in the field.....\$	3.50
Permanent camps and equipment.....	18.49
Legal expenses	587.36
Hetch Hetchy Aqueduct, Mountain Division..	1,208.17
Operating sawmill (lumber sales).....	1,058.82
Compensation insurance	487.47
Timber cut on Government land.....	498.21
Lower Cherry Power Development:	
Sales of power.....	67,528.10
Hetch Hetchy Railroad, operating revenue.....	16,626.13
<u>equipment</u>	<u>156.05</u>
Hetch Hetchy Railroad, construction and	
Golden Rock Ditch, operating revenue.....	269.30
Boarding house charges collected from em-	
ployees	83,921.76
Hospital buildings and equipment.....	2.43
Hospital maintenance	499.50
 Total credits	 <u>172,865.29</u>
Total expenditures, less total credits.....	<u>\$7,343,132.85</u>



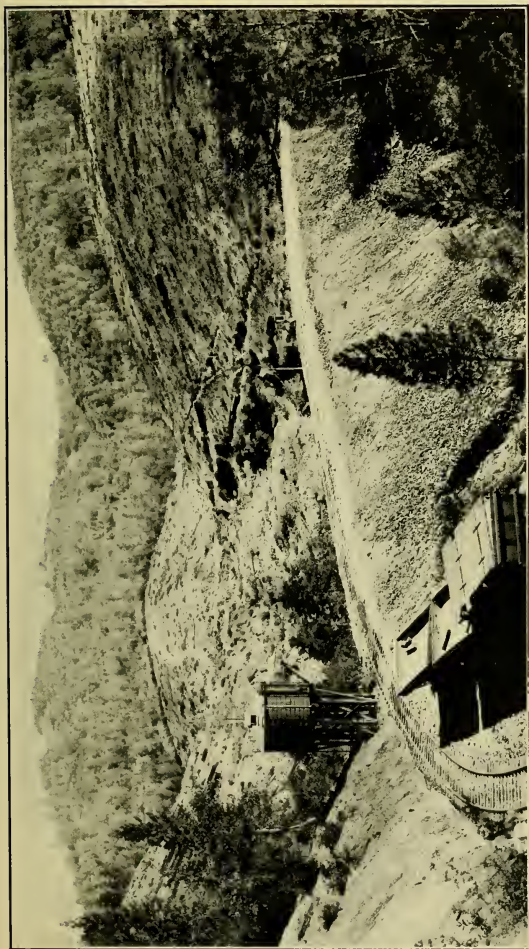
Hetch Hetchy Aqueduct. Interior of timbered tunnel at Priest, August 6, 1918.



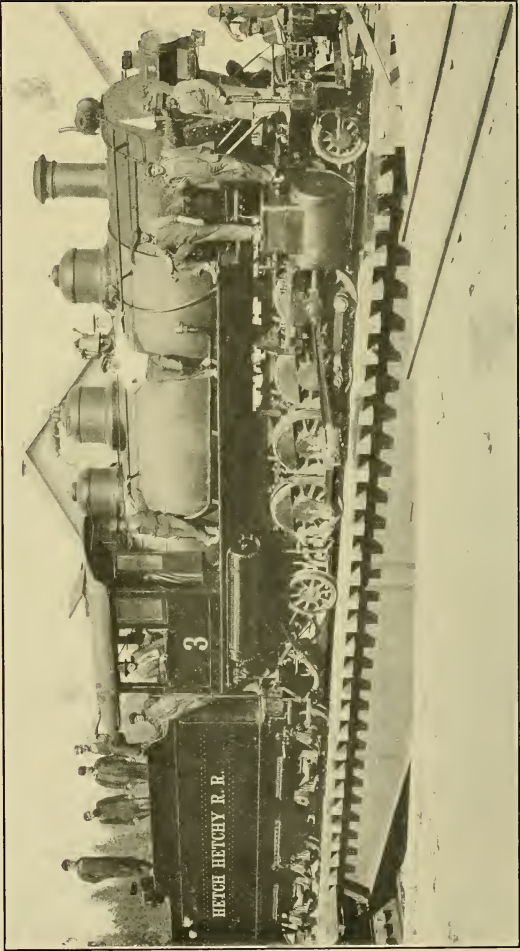
Hetch Hetchy Aqueduct. Face of Priest heading, 500 feet in from portal, August 6, 1918.



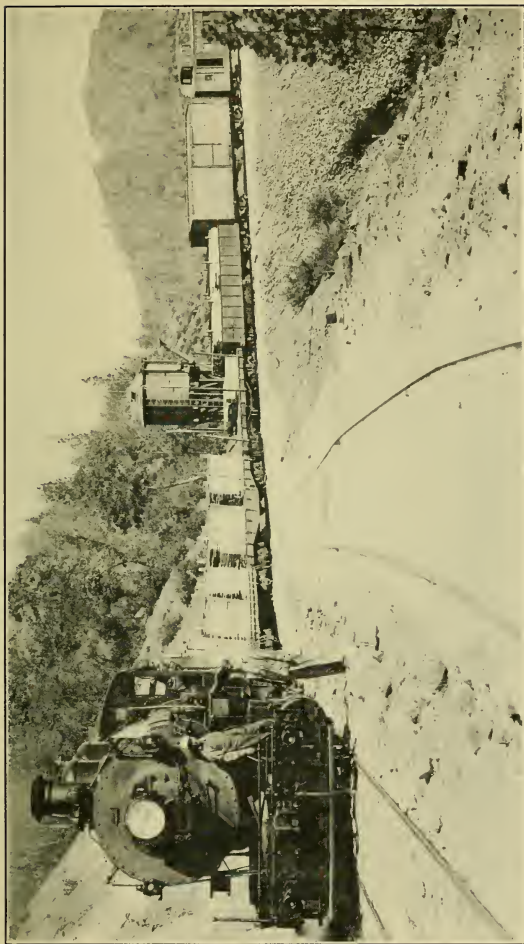
Hetch Hetchy Aqueduct. Electric storage battery locomotive hauling out muck train from Priest heading.



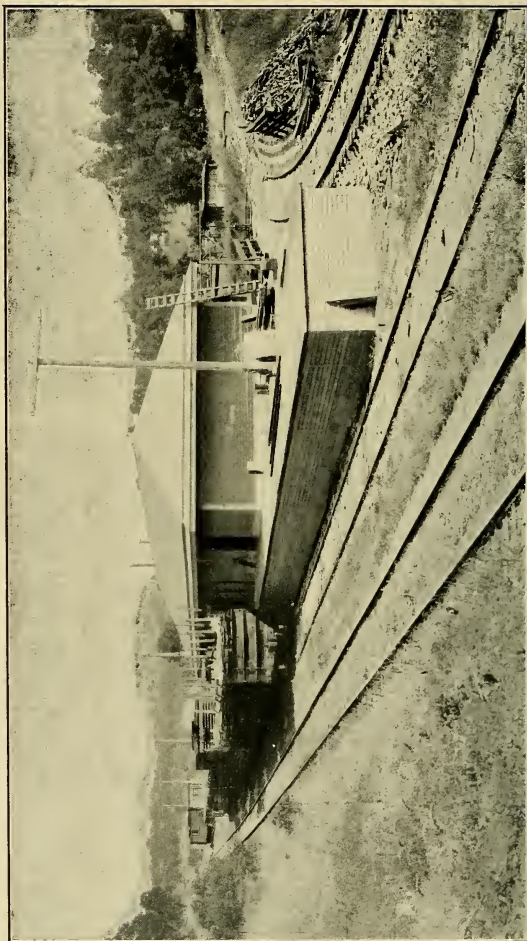
Hetch Hetchy Aqueduct. Dam site for Priest regulating reservoir. Tunnel portal is up gulch to right.



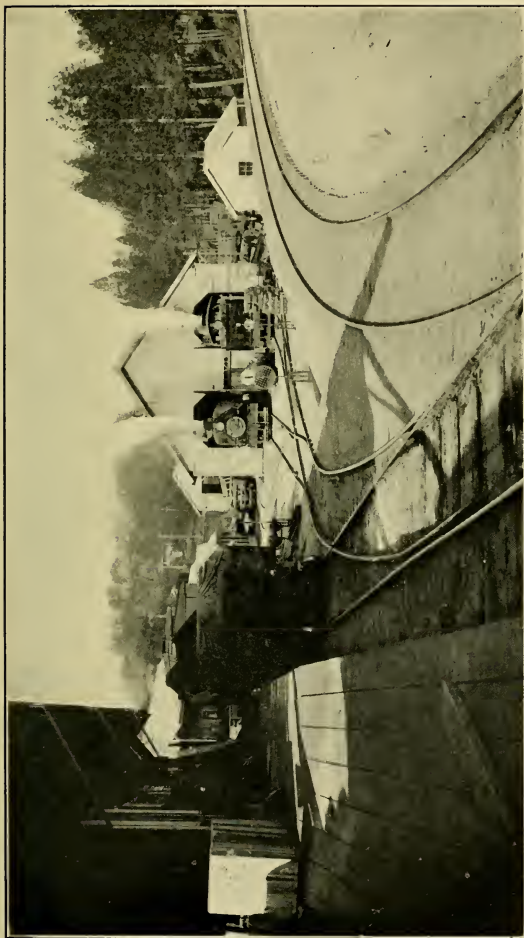
Hetch Hetchy Railroad. Mikado locomotive on turntable at Groveland shop.



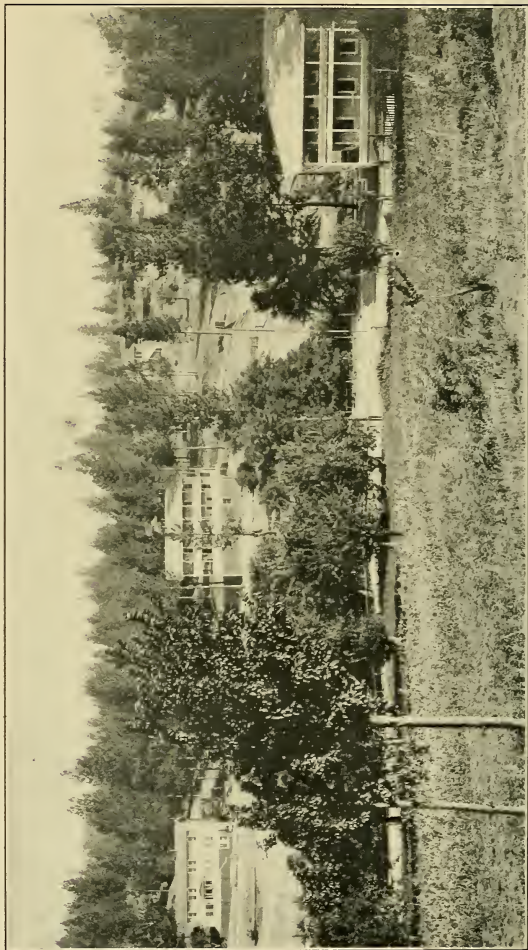
Hetch Hetchy Railroad. Mikado locomotive at Rattlesnake hauling train to Hetch Hetchy Junction.



Hetch Hetchy Railroad. Depot at Hetch Hetchy Junction, Hetch Hetchy Railroad track at right (on curve). Sierra Railway track at left.



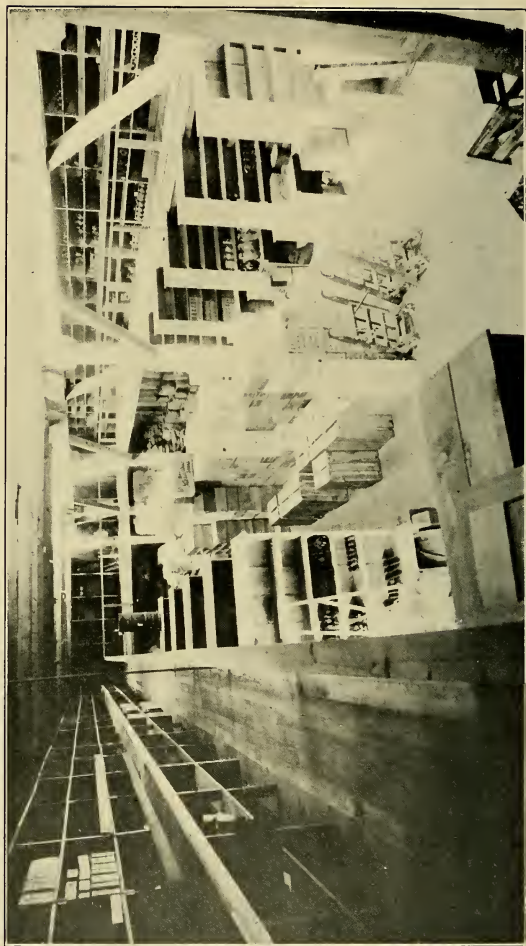
Hetch Hetchy Railroad. Yards, warehouses and roundhouse at Groveland. Main line track at right. Note auto truck fitted for running on track, on left hand track.



Groveland Headquarters. Buildings erected by the City. Single men's dwelling at left; hospital in center; office building at left; cottages for families in rear.



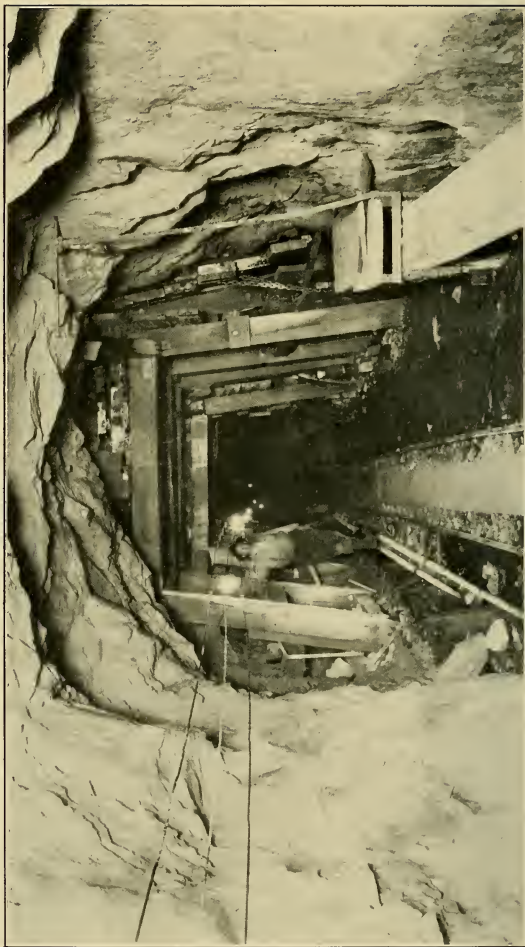
Groveland Hospital. Operating room.



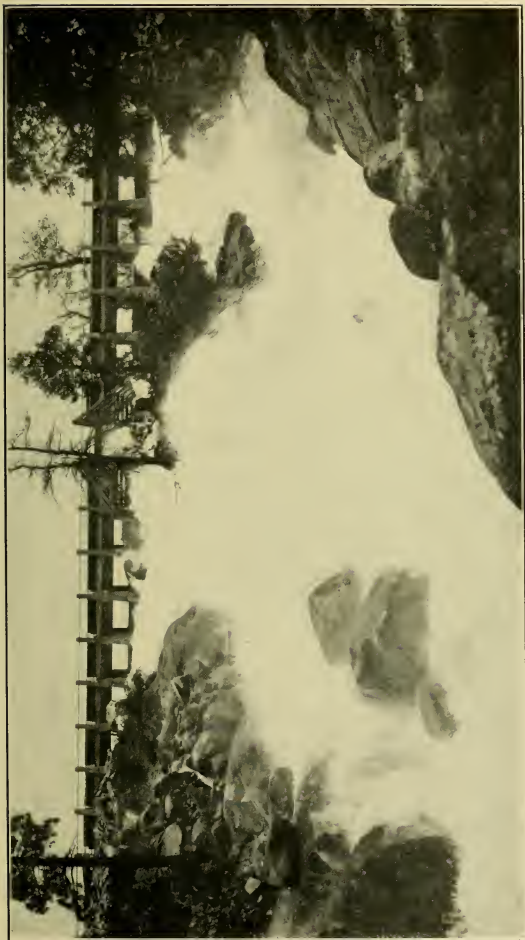
Groveland Warehouse. Interior.



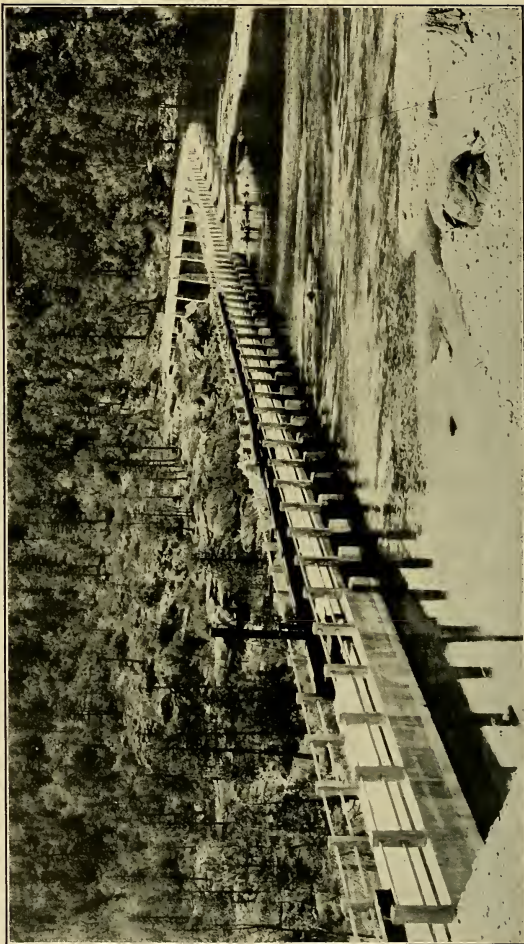
Hetch Hetchy Aqueduct. Shaft at Second Garrotte. Tunnel will be about 730 feet below ground surface at this point.



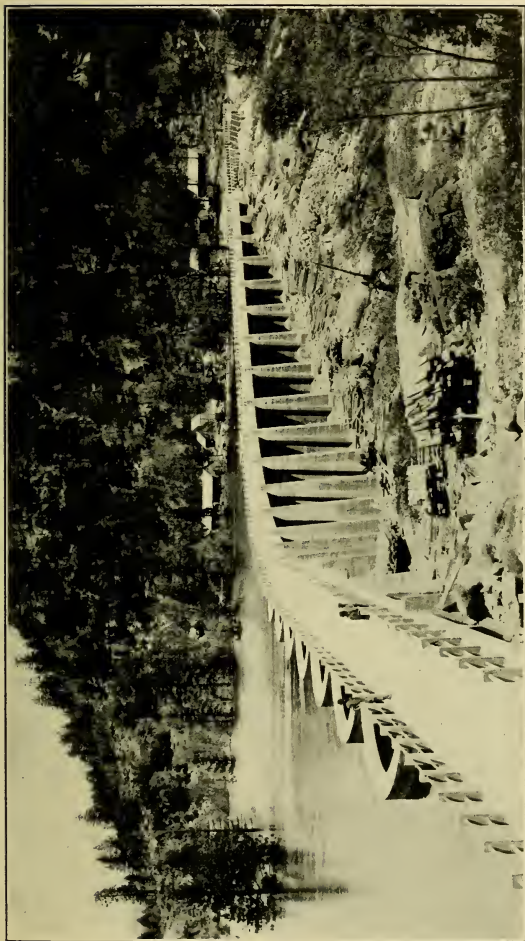
Hetch Hetchy Aqueduct. Interior of tunnel east of south fork of Tuolumne river. (Timbering shown is temporary.)



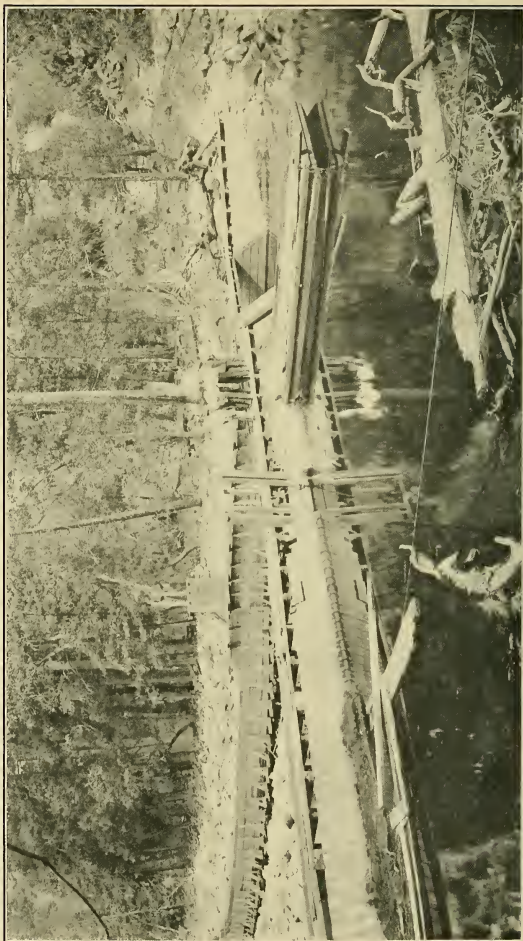
Eleanor Dam spillway overflowing during flood season of 1919.



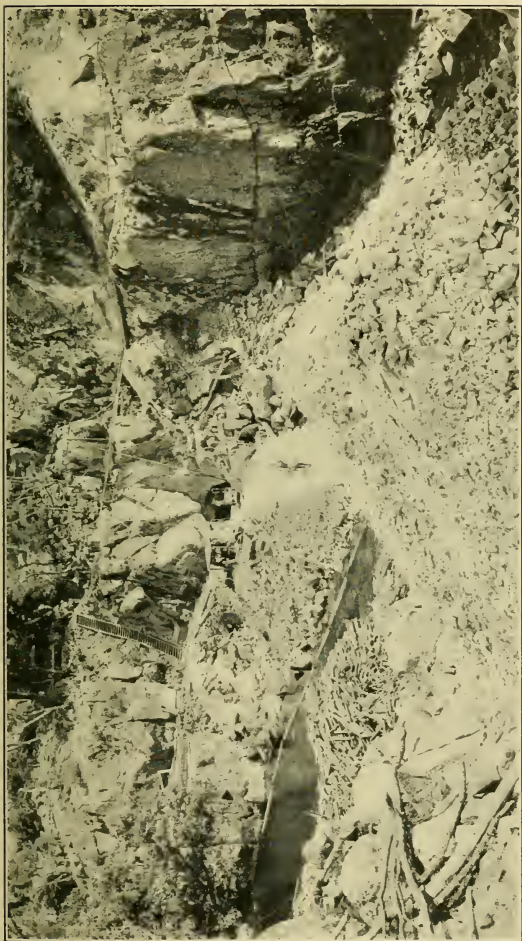
Eleanor Dam, looking westerly. Gravity wall and spillway in foreground. Reservoir full.



Eleanor Dam, looking easterly.



Crib dam and flume, one-half mile below Hetch Hetchy damsite, to divert Tuolumne river around channel change work.



View below Hetch Hetchy damsite, showing work in progress on extension of diversion tunnel.

DIVISION OF SURVEYS.

During the past fiscal year 622 orders for surveys were received at the public counter. Of these thirty-seven were for lot surveys and 585 were for surveys for public improvements and in answer to petitions or complaints. They include approximately as follows:

Nineteen hundred blocks and crossings, a total length of 759,300 lineal feet or 143 miles.

Precise levels were run covering about ninety-two miles. The total number of bench marks rechecked and established was 2308.

Fees collected and turned over to the City Treasurer amounted to \$7664.40.

Following is a detailed description of the work performed:

Surveys:

Made for	Number
Public Contracts	128
Private Contracts	110
Street Repair Department.....	29
Board of Public Works Commission.....	2
City Architect	4
Bureau of Engineering.....	312
	<hr/> 585
Lot Surveys	
Private owners	30
City Architect	5
Bureau of Engineering.....	1
Board of Education.....	1
	<hr/> 37

Total Surveys, 622.

Fees Received for Surveys

	1918	Public Improvements	Private Improvements
July	\$1,373.00		\$ 50.00
August	488.25		50.00
September	181.75		
October	322.00		146.00
November	173.50		
December	198.75		55.00
1919			
January	783.50		50.00
February	640.00		25.00
March	382.00		
April	401.00		155.00
May	657.75		100.00
June	1,294.50		137.40
	<hr/>		<hr/>
	\$6,896.00		\$768.40
Grand total.....	\$7,664.40		

PRECISE LEVELS

The following Precise Level Bench Marks were established or reconstructed in the different districts of the city during the fiscal year ending June 30, 1919:

Districts			
50 Vara	214	Bench	Marks
100 Vara	697	"	"
Mission	223	"	"
Western Addition	467	"	"
Potrero	472	"	"
Sunset	36	"	"
Other Districts	199	"	"
Total		2,308	" "
Number of miles covered.....		92	

MAPS ON FILE IN DIVISION OF SURVEYS, JUNE 30, 1919

Districts	Subjects	Photo- stats	Office Copies	Pro- files	Working Drawings	Tracings	Nega- tives	Prints
1 50 Vara.....	155	103	71	10	219	653	685	757
2 Western Addition.....	93	13	64	0	105	255	91	107
3 Western Addition.....	30	9	34	0	6	30	20	58
4 Richmond	79	10	58	0	57	113	63	81
5 Sunset	57	11	40	3	13	56	48	82
6 100 Vara.....	51	2	39	0	21	79	26	107
7 Potrero	123	29	73	0	40	79	71	163
8 Mission	95	11	59	0	92	75	41	151
9 South San Francisco.....	97	25	68	2	16	88	73	168
10 Holly Park, Precita Valley Lands, Gift Maps, etc.....	133	13	85	1	16	94	67	96
11 University Mound, Reis Tract, etc.....	82	82	52	0	3	57	48	73
12 Market St. Hmd., Park Hill, Flint Tract, etc.	165	52	108	4	35	205	187	296
13 Glen Park, Extensions, Sunnyside, etc.....	176	23	127	0	33	113	106	124
14 Ocean View, Lake View, City Lands, etc.....	87	3	62	0	12	79	70	156
15 San Miguel Rancho and New Tracts, etc.....	141	27	141	0	18	116	93	208
16 Lake Merced, G. G. Park, etc.....	25	4	20	2	3	26	16	42
17 Military Reservation, etc.....	36	25	33	11	4	35	30	67
Totals	1,625	443	1,134	33	695	2,153	1,759	2,735

**MAPS RECORDED IN THE RECORDER'S OFFICE,
July 1, 1918, to June 30, 1919**

Name	Date Recorded
------	---------------

1 Army St. Widening, San Bruno to De Haro St.....	December 13, 1918
2 Army St. Closing, Westerly from Burnett Ave....	November 21, 1918
3 Alms House Road (now Woodside Ave.).....	April 17, 1919
4 Army Street Widening at San Bruno Ave.....	May 20, 1919
5 Bosworth St. Widening at Congo St.....	May 13, 1919
6 Carson St. Width and Location Westerly from Douglas St.	November 12, 1918
7 Chenery St. Extension—Castro St. Westerly.....	December 18, 1918
8 Diamond St. Extension—Wilder St. Southerly.....	December 18, 1918
9 Ecker St. Widening and Closing—Jessie and Elim Al.....	April 29, 1919
10 Liberty St. Widening at Sanchez St.....	February 13, 1919
11 Market St. Extension, Castro St. to Ord St.....	October 2, 1918
12 Marina Gardens.....	November 13, 1918
13 McAllister St. Widening at Stanyan St.....	March 13, 1919
14 Madrone Ave. Opening at Taraval St.....	April 16, 1919
15 Monterey Blvd., St. Francis Wood—Westwood Park.....	March 24, 1919
16 Piper Alley Closing.....	April 29, 1919
17 Rayburn St. Opening Sanchez to Noe Sts.....	February 13, 1919
18 Stark St. Closing.....	November 21, 1918
19 Twin Peaks Blvd., St. Germain to Corbett Ave....	January 6, 1919
20 West Portal Ave. Widening.....	July 23, 1918
21 Worcester Ave. Widening.....	October 22, 1918
22 Woodside Ave. (formerly Almshouse Road).....	April 17, 1919
23 Yerba Buena Ave., St. Francis Wood—West- wood Park.....	March 24, 1919

SPECIAL PROJECTS AND RESTORATION WORK

Claremont Court Tract: Set monuments.

San Jose Avenue: Widening from Sickles avenue to the county line—preliminary surveys and maps.

Sunset District: Check and establish monument lines and set monuments on the following streets: Lincoln Way from Nineteenth avenue to the Great Highway, Great Highway from Lincoln Way to Sloat Boulevard, Sloat Boulevard from the Great Highway to Nineteenth avenue, Nineteenth avenue from Sloat Boulevard to Lincoln Way, and Taraval street from the Great Highway to Nineteenth avenue.

Sloat Boulevard between Fortieth and Forty-first Avenues: Surveys and studies to widen the boulevard and flatten dangerous curve.

Sloat Boulevard from Nineteenth Avenue to Junipero Serra Boulevard, and Junipero Serra Boulevard from Sloat Boulevard to Ocean Avenue: Establishing monument lines.

In the district south of Oakdale avenue and between Railroad avenue and San Bruno avenue, extensive surveys were made to establish monument lines and secure correct ties and connections between the adjacent tracts or homesteads.

Market Street Extension from Mono Street to Twenty-fourth Street: Surveys were made and accurate descriptions of each separate piece of property to be acquired were prepared.

The westerly boundary of the San Miguel Rancho from Eighth avenue to Sloat Boulevard was established and monumented.

Guttenberg Street, Morse Street, Mackey Street and Florentine Alley: Resurveyed and mapped for the purpose of widening, straightening and readjusting street conditions.

Laguna Honda Boulevard from Noriega to the Relief Home Tract: Surveying and mapping for proposed widening and definitely defining the location of said boulevard.

Almshouse Road from Dewey Boulevard to Portola Drive: Surveyed and map prepared showing exact width and location.

The new 100-foot to the inch scale city map in 300 sheets is being filled in and is beginning to fill a long-felt want.

A number of tests were made of the 110-foot standard measure which has been established in the northwest area-way of the City Hall, and a table prepared whereby the variation in the length of the standard due to change of temperature can be estimated to within .0005 of a foot merely by reading the thermometers and consulting a table.

Rincon Hill regrade survey (15-100 vara blocks): Cross sectioning each lot and securing location and elevation of improvements. This job is 90 per cent completed.

Stanyan Street Extension from Fulton Street north-erly: Plans and estimates in preparation.

The work of the division of surveys is under the charge of Chas. H. Holcomb, Assistant City Engineer, assisted by Harold G. Stahle.

ELECTRIC LIGHTING

Lighting City Hall:

Due to the vastness of the rooms in the City Hall some desks are located at a considerable distance from windows or other means of natural illumination. The occupants of the building have made complaint about the lighting of certain portions ever since moving into the building. In order that these difficulties might be corrected a new type of lighting fixtures for ceiling suspension has been selected for use in the City Hall, Mr. John Reid, Jr., passing on the architectural effect. Some fifty of these new fixtures have been installed at an average cost of \$15.00 apiece, the offices thus benefited being those of the Assessor, Registrar, Auditor and Treasurer. In the former two offices night work is very frequently necessary, making it imperative that good light be furnished. In the Recorder's office all

the fixtures in the copyists' room have been changed to give good lighting to those working on close work. Also twelve bracket lamps have been installed for the use of the employees of the title companies who rent space in this office. All of these changes not only greatly improve the lighting but at the same time materially lessen the cost for power.

Safety Station Lighting:

Due to automobile collisions with safety stations at various points in the city, plans and specifications have been prepared for the installation of warning lights on the various safety stations. Plans prepared contemplate a very neat and effective fixture to be placed on top of the pedestal at the end of each station. The estimated cost of this work for the eight safety stations on Market street is \$700.

GARBAGE DISPOSAL

At a meeting of the Board of Supervisors held July 1, 1918, the majority report of the Special Committee on Garbage Disposal, as published in the report of the Bureau of Engineering for the fiscal year ending June 30, 1918, was adopted. The Special Committee was instructed to proceed with the preparation of the necessary ordinances to be submitted to the Board for consideration, under which ordinances the recommendations of the committee, as approved, might become effective in operation.

Constant reminders from the Garbage Utilization Division of the Food Administration in Washington did not permit any one interested in the subject to become negligent of the advantages of utilization and conservation of all values, and the Food Administration is to be commended for this good work.

Bearing in mind the main objects to be attained: to stop, or at least to reduce, the large economic losses and wastes of garbage and rubbish values; to introduce and establish ways and means for the collection and disposal of

refuse that would be more economical and more generally satisfactory than the methods in use; and finally, to bring about the necessary modifications in such manner as to cause the least disturbance, the committee held numerous special meetings and conferences with parties affected.

Resolution No. 15926 (New Series) adopted July 22, 1918, directed the Board of Public Works to prepare specifications for the disposal of garbage and rubbish of the city and county, as a preliminary to receiving bids and entering into a contract for garbage disposal.

Specifications were prepared by the Bureau of Engineering in accordance with the adopted report of the Special Committee. This provided for household segregation of garbage and rubbish, and ordinances were prepared for making segregation effective. The Special Committee invited representatives from several organizations for civic improvement, the Chamber of Commerce, the Ladies' Center, the Apartment House Owners, the Scavengers' Association and others, and finally submitted a proposed ordinance which was passed to print by the Board of Supervisors on November 23, 1918.

The ordinance as passed follows:

BILL NO. 5083. ORDINANCE NO. —. (New Series.) Regulating the removal, disposal and conveyance of market refuse, rubbish, garbage and dead animals.

Be it ordained by the People of the City and County of San Francisco as follows:

Section 1. DEFINITION OF TERMS:

Sub. 1. The general term "Refuse" shall be construed to mean and include any and all organic or inorganic materials which are rejected, abandoned or discarded by the owners or producers thereof as offensive or useless, or no longer desired by said owners or producers thereof, all or any of which by their presence or accumulation may injuriously affect the health, comfort, or safety of the community by increasing disease or hazard of fire, or which cause an unkempt or disordered appearance to premises within said City and County of San Francisco.

Sub. 2. Wherever the term "Garbage" is used herein it shall be taken to be and include all animal and vegetable refuse from kitchens

and household waste that shall have been prepared for or intended to be used as food or shall have resulted from the preparation of food.

Sub. 3. Wherever the term "Market Refuse" is used herein it shall be taken to be and include decayed and unsound meat, fish, fruit, and vegetables from meat, fish, fruit and vegetable markets, and animal and vegetable refuse from such markets.

Sub. 4. Wherever the term "Combustible Rubbish" is used herein it shall be taken to be and include paper, pasteboard, carpets, rags, clothing, books, boots, shoes, straw, packing, barrels, boxes, furniture, and similar articles that will incinerate through contact with flames of ordinary temperature.

The term "Incombustible Rubbish" is defined to be ashes, bottles, broken crockery, glass and tin cans and other metallic substances, and like or similar articles or substances that will not incinerate through contact with flames or ordinary temperature.

Sub. 5. Wherever the term "Scavenger" is used herein it shall be construed to mean the person, firm, corporation, association or the agents or employees thereof to whom the City and County of San Francisco shall have awarded a contract, or designated as duly authorized to collect, receive, carry, haul or transport refuse, garbage or rubbish herein defined, within the said City and County.

Sub. 6. Wherever the term "Disposal Contractor" is used herein it shall be construed to mean the person, firm or corporation, or association to whom the City and County shall award a contract or designate as duly authorized to receive refuse collected by scavengers within the City and County of San Francisco.

Sub. 7. Wherever the term "Household" is used herein it shall be construed to mean any house, or building, or portion thereof which is designed, built, rented, leased, let or hired out to be occupied or which is occupied as the home or residence of one or more persons or families doing their cooking in said building.

Section 2. In order that "Refuse" may be properly conserved, handled and disposed of in a sanitary manner, "Refuse" shall be segregated by the producer into two general classes to be known as: (1) "Garbage," and (2) "Rubbish."

Sec. 3. Sub. 1. Householders, keepers of boarding houses, hotels, restaurants, stores or business places, and all producers of refuse as herein defined, shall keep segregated and separated the several classes of refuse designated as "Garbage," "Market Refuse" and "Rubbish," wherever such classes of refuse are produced.

All "Garbage" as herein defined shall be placed by the person, firm or corporation occupying the premises upon which such garbage is created, in a water-tight metal receptacle approved by the Board of Health, which receptacle shall be kept closed by a close-fitting metal cover. The contents of such receptacle shall be delivered not less than

twice a week to the person holding a permit from the Board of Health, issued under the provisions of Ordinance No. 4349 (New Series).

No refuse, other than "Garbage," shall be placed in said garbage receptacle.

Sub. 2. Every contractor or builder engaged in the erection or repair of a building is hereby required to provide a water-tight metal receptacle at or near such building being so erected or repaired within which receptacle shall be deposited any food or garbage cast aside by the employees or workmen engaged on such building. Said receptacle shall be kept closed by a close-fitting metal cover except at such times when opened for the deposit of such food or garbage.

Every employee or workman engaged in work upon said building or on the premises surrounding said building who consumes food on said premises is hereby required to deposit in such water-tight metal receptacle in the manner aforesaid all leavings of such food as may be unconsumed or rejected by him, and the casting aside on said premises or throwing about of any unconsumed food or of any garbage is hereby expressly forbidden.

Section 4. All householders, keepers of boarding houses, hotels, restaurants, stores or business places and all producers of refuse, as herein defined, shall exercise every precaution to prevent broken glass, crockery, poisons, metallie and other deleterious substances from becoming mixed with garbage.

Section 5. It shall be unlawful for any producer of refuse as defined by Section 1 of this Ordinance to fail to properly segregate "Garbage" from other refuse as required by Section 3 of this Ordinance or to fail to properly safeguard garbage as required by Section 4 of this Ordinance.

Section 6. It shall be unlawful for any person other than the duly authorized Disposal Contractor to incinerate or burn either garbage or rubbish or to dump the same upon any vacant lands or into the waters of the bay, or to dispose of same by burial except by special permit of the Board of Health.

Section 7. Sub. 1. The water-tight metal garbage receptacles herein required shall be made of galvanized iron or of material equally satisfactory to the Board of Health, and shall be inspected and approved and so stamped or marked by the Board of Health. No person, firm or corporation shall sell, offer for sale, or otherwise dispose of any such receptacle to be used as a garbage can which does not have upon it the inspection stamp or mark of the Board of Health.

Sub. 2. It shall be the duty of every owner, manager or person in possession of any boarding house, hotel, apartment, restaurant or cafe, and of every person occupying a dwelling or flat or apartment within the City and County of San Francisco, to provide, or to cause to be provided, and at all times to keep, or cause to be kept, portable vessels,

tanks or receptacles as in this Ordinance prescribed for holding of garbage of a capacity not less than three (3), nor more than sixteen (16) gallons, which shall be provided with a bail or handles on the outside thereof and otherwise comply in full with the provisions of Subdivision 1 of this section.

Each vessel, tank or receptacle must be kept clean and sanitary and free of encrustations of grease or refuse, and the use of lime, carbolic acid or any other disinfectant is herewith strictly prohibited. All cleansing of garbage receptacles is to be done with caustic soda dissolved in hot water.

Sub. 3. Each such vessel, tank or receptacle shall be kept in a place accessible to the scavenger, and satisfactory to the householder.

Section 8. All "Rubbish" shall be kept in a proper receptacle in a dry condition and no rubbish as herein defined shall be at any time mixed with garbage.

Section 9. All refuse shall be taken promptly by scavengers as directly as possible, on the day of collection, to the plant of the Disposal Contractor. No scavenger shall retain, sell or otherwise dispose of any materials nor carry any such rubbish to any barn, garage or premises for storage or segregation.

Section 10. All refuse within the City and County of San Francisco shall be collected and transported through the streets of the said City and County by scavengers only, at the time, rates for collection, service and in the manner hereinafter set forth.

Each class of refuse is to be kept separate from and unmixed with any other class of refuse and is to be transported and delivered by the scavenger to the Disposal Contractor in a segregated and unmixed condition.

Section 11. The person collecting such refuse under the terms of the preceding sections shall deposit the contents of all such receptacles directly into the wagon provided therefor, and shall deliver the contents of such wagon to the Disposal Plant on the same day that such refuse was placed therein. Any failure on the part of the person so collecting such refuse to observe the requirements of this section will be sufficient to justify the revocation by the Board of Health of the permit issued in accordance with the provisions of Ordinance No. 4349 (N. S.).

Section 12. In addition to the revocation of the permit for the cause set forth in Section 11 hereof, the Board of Health shall have authority to hear complaints against any person holding such permit and to revoke the same for insolent or threatening conduct, for the failure to collect refuse under the terms of any contract, or for the violation of any sanitary regulations made by such Board.

Section 13. Sub. 1. It shall be the duty of every householder or tenant occupying any private residence, or flat or apartment within the

City and County of San Francisco to arrange or cause to be arranged with the scavenger or collector for the frequency of the collections and removals of garbage and rubbish from the premises.

Sub. 2. Garbage shall be collected and removed by the scavenger or collector not less frequently than twice each week. Rubbish shall be collected and removed by the scavenger or collector at such intervals as the conditions of the householder or tenant may demand in order to prevent unnecessary, unsightly or dangerous accumulations of such rubbish and all rubbish shall be collected and removed not less frequently than twice each month.

Sub. 3. Every householder or tenant of a dwelling or flat in the City and County of San Francisco shall pay to the scavenger or collector for the removal of garbage and rubbish such price as may be agreed upon between the householder or tenant and the scavenger or collector, according to the requirements of the service, but the rates charged for such removal by the scavenger or collector shall be not more than that fixed by the Schedule of Rates set forth in the Ordinance fixing the maximum rates to be collected for the removal and disposal of garbage and refuse.

Section 14. It shall be the duty of every resident, householder or tenant occupying any private residence or flat or apartment within the City and County of San Francisco to provide, or cause to be provided, and at all times to keep, or cause to be kept, portable vessels, tanks or receptacles for holding rubbish and ashes, each such vessel, tank or receptacle shall be of metal or other incombustible material and shall be tight. The same shall have a capacity of not more than sixteen (16) gallons and shall be provided with a bail or handles on the outside and with a tightly fitting cover, which cover shall not be removed except when necessary.

Such vessels, tanks or receptacles shall be kept or placed as is prescribed for the placing of receptacles for garbage.

Section 15. It shall be unlawful for any person, firm or corporation to remove or convey, or to cause or permit to be removed or conveyed, any refuse upon or along any public street, alley, or other public place, except in tight vessels, receptacles or tanks, or wagon boxes mounted on wheels, and every such vessel, tank, receptacle or wagon box when containing refuse shall be securely and tightly covered in such manner as to prevent the contents thereof or any odors escaping therefrom. Every such vessel, receptacle, tank or wagon box shall be thoroughly cleansed daily and same shall be disinfected at least twice each week. Every vehicle carrying any such vessel, receptacle, tank or wagon box shall be so loaded and driven that none of the contents thereof shall fall therefrom, and there shall be painted upon each side of every vehicle containing any such vessel, receptacle, tank or wagon box the number of the permit issued therefor by the Board of Health, pursuant

to the provisions of this Ordinance, in black letters and figures not less than four inches in height and on a white background.

Each vessel, receptacle, tank or wagon-box used for the purpose of conveying garbage or other refuse containing liquids along or upon any public street, alley or other public place shall be water-tight.

All vehicles for the transportation of swill, garbage or rubbish of any character shall be subject to the approval of the Board of Health before licenses for their operation are issued.

Sub. 2. Before any person, firm or corporation shall remove or convey refuse, combustible or incombustible rubbish upon or along any public street, alley or other public place, an application shall be filed with the Board of Health for a permit, which application shall be signed by and shall contain the address of such applicant. Such applicant shall agree to conform to and obey the ordinances of the City and County of San Francisco now in force or that may be hereafter adopted and all regulations of the Board of Public Works and of the Board of Health of said City and County relative to the removal, disposal and conveyance of refuse, combustible and incombustible rubbish. He shall further agree to dispose of, or cause to be disposed of, all rubbish obtained from places of business and all refuse obtained from any market or produced or created in any part of the City and County of San Francisco. He shall further agree not to cause or permit to be disposed of any of such rubbish or refuse at any place other than the plant of the Disposal Contractor to whom the City and County shall award a contract, and will not sell or deliver or cause or permit to be sold or delivered any of such rubbish or refuse to any person, firm or corporation that disposes of or will dispose of the same at any place other than the reduction or disposal plant of the Disposal Contractor or licensed collector for such Disposal Contractor above mentioned or to such contractor as may have obtained from the City and County of San Francisco a contract for the removal of refuse, combustible and incombustible rubbish.

Sub. 3. The condemnation of offal from wholesale fish, vegetable or fruit markets, and the condemnations of all food products and the carcasses of any animal condemned by the Board of Health shall be removed by the Garbage Disposal Contractor free of charge.

Sub. 4. The following rate shall be charged for the removal of dead animals from private premises to the disposal plant:

For each dead horse or cow, the sum of \$2.50; cats and dogs, \$0.50 per head.

All dead animals upon the public streets or highways and any public park or square shall be removed without cost to the City by the Disposal Contractor.

Any animal so removed shall become the property of the Disposal Contractor.

Section 16. It shall be unlawful for any person, firm or corporation, their agents or employees, to hinder, threaten, impede or obstruct any licensed scavenger in the performance of his duty as defined by this Ordinance.

Section 17. The Board of Health is hereby empowered to make such further regulations as may be necessary to carry out the intent and purposes of this Ordinance.

Section 18. All members of the Police Department and employees of the Board of Health and of the Board of Public Works are hereby specifically required to enforce the provisions of this Ordinance, and shall have the right to enter any and all premises for the purpose of ascertaining the sanitary condition thereof, and any person denying or obstructing such entry shall be subject to the penalty herein provided.

Section 19. Any person, firm or corporation violating any of the provisions of this Ordinance shall be guilty of a misdemeanor and upon conviction thereof shall be punished by a fine of not more than five hundred (\$500) dollars or by imprisonment in the County Jail for not more than six months, or by both such fine and imprisonment.

Section 20. Ordinance No. 12 (Second Series), approved November 4, 1897; Ordinance No. 65, approved May 9, 1900; Ordinance No. 357 (New Series), approved February 3, 1908; Ordinance No. 1858 (New Series), approved April 3, 1912, and all other ordinances conflicting with the provisions of this Ordinance are hereby repealed.

Section 21. This Ordinance shall take effect immediately.

Passed for Printing—Board of Supervisors. San Francisco, November 23, 1918.

Ayes: Supervisors Brandon, Deasy, Gallagher, Hocks, Hynes, Lahaney, McLeran, McSheehy, Mulvihill, Nelson, Schmitz, Welch.

Absent: Supervisors Hayden, Hilmer, Kortick, Power, Suhr, Wolfe.

JOHN W. ROGERS,

nov25-5t

Acting Clerk.

In the meantime specifications for garbage and rubbish disposal were prepared, and Ordinance No. 4705 (New Series) approved October 29, 1918, authorized and directed "The Board of Public Works to advertise for bids and enter into a contract for the disposal of garbage and rubbish according to the specifications prepared therefor and approving such specifications."

Proposals were then called for by the Board of Public Works and bids were received on January 22, 1919. Mr. Chas. F. Reddy bid \$1.26 a ton for all the segregated garbage

delivered to him at the water front to one or more of three proposed receiving stations, one in the North Beach District, one at the foot of Channel street and the third in the Islais Creek District. Mr. Reddy also bid \$1.34 a ton for "Garbage reasonably free from water," and \$1.51 a ton for "Garbage free from water." No bids for the disposal of rubbish under the specifications or for the collection of garbage and rubbish, which were also provided for in the proposal, were received, and on the 29th day of January, 1919, award of contract under Resolution No. 61179 (Second Series) was made to Charles F. Reddy in the sum of \$1.26 per ton for all garbage delivered during a contract period of ten years. The contract could not become effective, however, until the segregation ordinance should be put into operation, and as this ordinance has not yet been passed by the Board of Supervisors the contract is not in effect at the end of the fiscal year, June 30, 1919.

Regarding the destructor which has been operated by the Sanitary Reduction Works since its purchase by the city, the management notified the city that they no longer desired to continue the operation of the plant because the expenses of operation had increased both in wages and materials required for maintenance and the volume of refuse delivered to the plant had considerably fallen off, so that they were running behind financially each month. Mr. Panario, of the Sanitary Reduction Works, asked that he be permitted to raise the price charged scavengers for the delivery of refuse from the fixed rate of 60 cents to 80 cents per ton, which he thought would be sufficient to run the plant without loss. This increase was not granted by the Board, and a short time later the company again demanded to be released from its obligations to run the plant.

Under date of September 23, 1918, the Scavengers' Protective Union proposed to take over and operate the destructor on their own account, and Resolution No. 16097 (New Series) approved September 25, 1918, accepted the proposal and authorized agreement with the scavengers in accordance with their offer. Arrangements were com-

pleted and the scavengers began operating the plant on October 4, 1918.

During the latter part of October the influenza epidemic had caused so much sickness among scavengers and operatives of the destructor that the bins became filled with refuse and there were not enough hands at the plant to handle the furnaces to anything like capacity. Not more than half the scavengers were at work throughout the city, and the condition became quite acute for several days. This was relieved as rapidly as possible by many scavengers working continuously overtime and doing the best possible to correct the unfortunate condition.

Under date of October 5, 1918, Mr. Richard Schmidt, 407 Piñe street, made a proposition to the Board of Supervisors wherein he offered to collect and dispose of all the city's garbage, refuse and waste of every kind and character if such garbage, refuse and waste shall first be segregated in accordance with the provisions of the proposed Segregation Ordinance and in accord with the proposed ordinance fixing the price of the disposal of garbage, and to pay to the city for the exclusive privilege and right of collection and disposal of all such garbage, refuse and waste the sum of \$180,000 per year, payable in equal monthly installments of \$15,000, under the following conditions:

“First. That the rate charged householders for the collection of garbage shall be the same as the rate existing today, thereby preventing any increase of the charge upon the general public for collection.

“Second. That this right and privilege be awarded to the undersigned for the period of twenty years and provided that at any time after the expiration of five years the city shall have the right to cause all rights acquired under such privilege to be transferred to it upon the purchase of the equipment and an additional sum of 10 per cent of the cost of such equipment.

“Third. The contractor will provide all the necessary automobile trucks, teams, wagons, machinery and appliances to collect, handle and dispose of all refuse.

“Fourth. The contractor proposes to utilize all values in the garbage, refuse and waste of any kind and all that is otherwise useless will be mechanically and chemically treated and used to fill waste or water covered lands, and

“Fifth. It is proposed that if the city elect to accept this proposition, the proposer will agree to commence performance under the agreement within sixty days from date of execution of contract.

“**Proposition No. 2:** In the event that the segregation of garbage shall not become effective, then and in that event it is offered to dispose of all the city's refuse at the present ordinance rate of 60 cents per ton delivered by the scavengers and pay the city \$1000 per month therefor. This offer made upon the condition that if it is accepted the contractor shall be permitted to continue the operation for a period of at least six months and that termination of contract shall be subject to notice of sixty days.”

To relieve as far as possible the then existing very unsatisfactory conditions, and because of the inability of the destructor to dispose of the refuse, it was decided to permit Mr. Schmidt, under his Proposition No. 2, to dispose of the refuse as collected by the scavengers and without segregation. Dumping was begun on Army street but was discontinued after three days because of its nuisance features, and an arrangement was made with the Scavengers' Association whereby they should again take over the operation of the Sanitary Reduction Company's destructor under the supervision of the Board of Public Works.

Since November 15, 1918, the scavengers have been operating the plant and maintaining it in good working order. The scavengers have been assessing themselves at one dollar a ton for all refuse delivered to the destructor and this has been found enough to pay all wages, ordinary maintenance and repairs, industrial accident insurance and other running expenses, but it does not provide any return to the city on the cost of plant or interest on the investment.

It was anticipated that some disposal contractor would be interested in using either the old destructor plant or the newer Islais creek incinerator, but no offers were made for their use.

It will be seen that the status of the refuse disposal question is practically the same as it was a year ago. Much opposition to segregation of garbage has developed, especially since the close of the war.

BLUE PRINTING AND PHOTOGRAPHIC WORK

Fiscal Year 1918-19

H. B. CHAFFEE, Photographer in Charge.

	Square Feet					Cloth	Black	Photostat Prints
	Blue Prints	Blue Line Prints	Black Line Prints	Negatives	Blue			
City Engineer's Office.....	35,508	31,967	4983	4075	1256	.....	4145	4452
City Architect's Office.....	9,786	10,032		699	858		180	213
Board of Health.....							185	5398
Board of Public Works.....	45						5	155
Mayor's Office.....							7	10
Street Cleaning Dept.....								
Civil Service Commission.....								
Auditor.....								104
Assessor.....	114,100	142		71			13	3
Fire Department.....	358	200		17	34		16	189
Bookkeeper. B. P. W.....							144	184
Street Repair Dept.....	250	442		4				
Municipal Railways.....							28	
Board of Supervisors.....		2,529		116			8	598
Board of Education.....	714							
Totals	160,761	45,312	4983	4982	2148	.....	4731	11,406

	Photo Negatives			Photo Prints						Enlargements		
	5X7	8X10	8"X3'	4X6	5X7	8X10	8"X3'	8½X11	14X17	16X20	20X30	
City Engineer's Office.....	485	376	9	808	3888	1687	21	276	20	67	1	
City Architect's Office.....		26			32	277			6			
Board of Health.....	36				476	30						
Board Public Works.....		11		24	74	105				8	3	
Mayor's Office.....						71						
Street Cleaning Dept.....					83							
Civil Service Commission.....					25	50						
Auditor												
Assessor												
Fire Department.....												
Bookkeeper, B. P. W.....					108							
Street Repair Dept.....												
Municipal Railways.....							10					
Board of Supervisors.....												
Board of Education.....												
Totals	521	413	9	832	4686	2220	31	276	26	75	4	

NATIONAL SERVICE

The following members of the City Engineer's staff served in the Army and Navy during the war:

Anderson, Ed. C.	Corporal	
Barnett, Joseph N.	1st Lieutenant	Engineers
Behan, Chas. E.	Corporal	Engineers
Bernach, Walter A.		Engineers
Best, John H.	Sergeant	Infantry
Borg, John		
Casey, John J.	2nd Lieutenant	Engineers
Cowles, Robert F.	1st Lieutenant	Engineers
Criglar, Joseph W.	1st Lieutenant	Ordnance
Darlington, F.	1st Lieutenant	Engineers
Donnelly, William F.	1st Lieutenant	Coast Artillery
Flamm, Ivan	Private	Coast Artillery
Ford, John P.		
Garen, Ernest A.	Corporal	Medical Corps
Glick, Leo	Sergeant	Ordnance
Gurley, Dorris	Aviator	Navy
Hinkson, Frank E.		Engineers
Jacobson, Ed.		Infantry
Keville, Frank	Sergeant	Ordnance
Kline, Geo. R.	1st Lieutenant	Engineers
Kurtz, Frank	Cook	Infantry
Merrill, Whitney S.	1st Lieutenant	Engineers
Moss, C. Eugene	1st Lieutenant	Engineers
O'Shaughnessy, Francis J.	Private	Engineers
Rae, James H.	Ensign	Navy
Riordan, Eugene J.	1st Lieutenant	Engineers
Robison, Wilfred A.	Ensign	Navy
Ryan, John H. Jr.	1st Lieutenant	Engineers
Sanchez, Louis A.	1st Lieutenant	Engineers
Schaufele, Herbert J.	1st Lieutenant	Engineers
Schlappi, John J.	Private	Coast Artillery
Smith, Jr., Wm. A.	Corporal	Aviation
Stahl, Carl	Seaman	Navy
Stocker, Leslie W.	1st Lieutenant	Engineers
Todd, Oliver J.	Captain	Engineers
Tuttle, Howard E.	Master Engineer	Engineers
Wilcox, P. E.	Corporal	Engineers
Wolcott, L. O.	1st Lieutenant	Engineers

The men who joined the colors were given leaves of absence and retained their Civil Service standing. On discharge from the Army or Navy, all who apply for reinstatement in the city service are taken back.

CONTENTS

	Page
LETTER OF TRANSMITTAL.....	1
MUNICIPAL RAILWAY SYSTEM.....	3
Ferry Terminal	3
Ocean Avenue Agreement.....	5
Taraval Street Agreement.....	6
Contract Work During the Fiscal Year.....	9
Contract Expenditures out of Earnings (table front of page)	15
Photographs	15-20
ELECTRIC LIGHTING, City Hall and Safety Stations.....	103
BOULEVARDS AND STREETS.....	21
Amount and Cost of Street Work.....	24
Photographs	29-44
SEWER SYSTEM	45
Photographs	50-51
HETCH HETCHY WATER SUPPLY.....	52
Headquarters Organization	52
Headquarters Office Engineering.....	53
Hetch Hetchy Dam.....	53
Hetch Hetchy Dam Outlet System.....	54
Hetch Hetchy Aqueduct Design.....	56
Amazon Receiving Reservoir.....	56
Priest Dam	57
Dumbarton Crossing	57
Negotiations with War Industries Board.....	58
Field Operations	59
Field Headquarters Organization.....	60
Employees' Quarters at Groveland.....	60
Medical Attention and Hospital Service.....	61
Storehouse at Groveland.....	62
Hetch Hetchy Damsite Work.....	62
Lake Eleanor Dam.....	64
Aqueduct Tunnel	64
Hetch Hetchy Railroad Operation.....	66
Tourist Travel on Hetch Hetchy Railroad.....	67
Railroad Construction	68
Railroad Equipment	69
Lower Cherry Power Development.....	69
Sawmill Operation	74

HETCH HETCHY WATER SUPPLY—Continued.	Page
Contract Data	75
Hetch Hetchy Dam Contract.....	75
Tabulated Data, all Contracts.....	Table Insert
Statement of Expenditures, Hetch Hetchy Water Supply.....	77
Photographs	80-97
DIVISION OF SURVEYS.....	98
Special Projects and Restoration Work.....	102
GARBAGE DISPOSAL	104
BLUE PRINTING AND PHOTOGRAPHIC WORK.....	116
NATIONAL SERVICE	118

ANNUAL REPORT
OF THE
BUREAU *of* ENGINEERING
OF THE
DEPARTMENT OF PUBLIC WORKS
CITY AND COUNTY OF
SAN FRANCISCO

FISCAL YEAR ENDING JUNE 30, 1920

M. M. O'SHAUGHNESSY,
CITY ENGINEER



Great Highway, Ocean Beach Esplanade. Winter Scene.

Annual Report of the City Engineer

1919-1920

CITY AND COUNTY OF SAN FRANCISCO

Department of Public Works,
Bureau of Engineering

July 1, 1920.

To His Honor, the Mayor,
The Honorable Board of Supervisors, and
The Honorable Board of Public Works of the
City and County of San Francisco.

Gentlemen: I beg herewith to transmit the annual report of the Bureau of Engineering for the fiscal year 1919-1920.

Hetch Hetchy Water Supply:

Activities were prosecuted on this project throughout the year as rapidly as available finances would permit. Due to the high price of money and the non-saleable character of our municipal bonds bearing $4\frac{1}{2}$ per cent interest, the amount of funds was very limited. However, arrangements were made by which on August 4, 1919, an appropriation of \$5,500,000 was financed for the construction of the Hetch Hetchy Dam with siphon spillways under a contract awarded to the Utah Construction Company for \$5,447,792.50, the structure to be completed within three years. The Utah Construction Company proceeded to put in a plant and prosecuted construction actively in spite of the fact that on November 5, 1919, suit was entered by one Jones, a taxpayer, and LeHane, a Modesto lawyer, to block the performance of

the contract. After a due hearing in the Superior Court of San Francisco by the Honorable Judge George E. Crothers decision was given in favor of the city on February 5, 1920, which disposed of this controversy.

Due to the shortage of funds to construct the aqueduct, which was being economically performed by the city on a day labor basis, it was found necessary to put up to contract the construction of those tunnels and on May 3, 1920, a contract was awarded to the Construction Company of North America for the sum of \$7,291,902. On May 12, 1920, certain interested citizens procured a restraining order against the execution of this contract, which, after trial before the Honorable Judge Frank J. Murasky, was dissolved on June 16, 1920. Appeal was then taken from this decision to a higher court, so that work under the contract was considerably delayed.

On August 5, 1919, the Honorable Judge C. W. Nicol of Tuolumne County decided in Sonora, California, that the City of San Francisco had the right to acquire the 80 acres of land owned by the Yosemite Power Company in Poopenaut Valley. Subsequently, in trial before a jury, a verdict on the valuation of this piece of property was procured and payment afterwards made to the Yosemite Power Company for this piece of land. This suit practically terminated all the controversies for the City of San Francisco, extending over a period of 19 years, for its rights in the Sierra Nevada Mountains.

The project was visited by His Honor, Mayor Rolph, July 23rd to 26th, 1919; by the Board of Supervisors September 23rd to 26th, 1919, and June 15th to 18th, 1920; it was also visited by a body of 50 men representing the Chamber of Commerce, Commonwealth Club, and other business elements of the city between October 17th and 20th, 1919; by the City Council, mayors, engineers and attorneys of the transbay cities of Oakland, Berkeley, Alameda and Richmond on November 6th to 9th, 1919, when very friendly expressions were offered by those representatives of the trans-

bay cities in regard to this project. A large technical body comprising 40 members of the American Society of Civil Engineers went over the project between the 12th and 15th of June, 1920. Those men represented different cities and communities in the State of California, as well as large commercial enterprises, and were very flattering in their comments on the project.

The only suit so far developed with regard to construction work in the mountains, instituted by F. Rolandi, for claims on the construction of the roadbed of the railway and track work, was settled, on recommendation of the Law Department, on February 4, 1920.

Bids on the large valves necessary to pass the water through the Hetch Hetchy Dam were received March 3, 1920, but due to the shortage of funds contracts were not awarded until a subsequent date. Those valves are now under construction and will be completed in ample time to install in the concrete work of the dam.

Proposal to purchase the property of the Spring Valley Water Company was carefully considered in connection with many conferences with the Mayor and Supervisors on this subject, and this department assisted in presenting facts before the Railroad Commission, which was subsequently to place a valuation on the property. It is the hope of this department that this valuation will be accepted by the public of San Francisco and thereby solve for all time the entire ownership of the municipal water supply, which is the only sane solution of this problem.

Boulevards:

During the past year the development of our boulevard system has been along the lines of widening and paving the present main traveled routes, such as the Great Highway and Sloat Boulevard. In addition to this, a section of the Market Street Extension 1900 feet long, over Twin Peaks Tunnel, has been paved, and plans and specifications for improving an-

other section are ready, which, when completed, will provide a much needed highway. Surveys have been made by the State Highway Engineers and rights-of-way are being procured for the Sky Line Boulevard, this being done in conjunction with our three neighboring counties, San Mateo, Santa Clara and Santa Cruz, as members with this County of Joint Highway District No. 1.

The building of the Army Street retaining wall and the grading of Evans Avenue are steps towards constructing highways in our industrial section in the southeast section of our city and tend to stimulate the growth of our industries.

Public Comfort Stations:

There has always been a need of public convenience stations in this city, and with the closing of the saloons the lack of comfort stations has been greatly felt. The improvement of the Great Highway and the Esplanade has attracted the public to our Ocean Beach in such numbers that the construction of comfort stations along the beach has become an imperative necessity. Study of the plans of modern comfort stations constructed throughout the large cities of the world has been made and the best and most modern features have been embodied in the plans for the station now under construction at the Ocean Beach Esplanade. The successful operation of this station will only partially supply the need of this section and it is to be hoped that appropriations will be forthcoming in the future for the construction of other stations here and throughout the city.

Sewers:

Only such new construction and reconstruction of sewers were attempted as were absolutely necessary for the preservation of health and sanitary conditions.

Rincon Hill:

The use of level land near the water front for commercial purposes is a vital one in this city, and the Rincon

Hill Regrade Project is of such importance as to have warranted the amount of preliminary work on the subject accomplished by this office during the past year. With the completion of the assessment district, a most comprehensive set of plans and sections with all necessary data will soon be ready to set before the public.

Naval Base:

Knowing the advantages offered by the Hunters Point district as a site for a United States Pacific Coast Naval Base and the benefits that the city would derive from its selection as such by the Government, we have compiled and set before the proper commission, in co-operation with the Commercial Development Committee of the Board of Supervisors, full reports and data on all phases of the subject, which should insure our success in the selection of a site.

Projects:

The Aquatic Park, City Planning, and Marin-San Francisco Bridge, and special improvements of various streets have also received necessary attention, the importance of these projects requiring careful study.

Municipal Railways:

Lack of money and the possibility of the purchase of the United Railroads has resulted in no extensions to the Municipal Railway lines, care being centered on maintenance of the high standard of trackage and equipment installed at the commencement of municipal operation. The Laguna Honda Station has been provided with an elevator; the relocation of the Union Street line, and the construction of the Polk Street spur, the Presidio loop and the connection between the Market and Stockton Street lines were all considered as maintaining service. The service on the Union Street line has been handicapped by the cars in use, so the development of a special type of car for this line has been

undertaken. The increase in receipts of 20 cents per car hour throughout the year has been largely due to the superior service offered the public by the Municipal lines.

Paving:

The amount of street paving accomplished has shown a marked increase, asphaltic concrete wearing surface with a paint coat on a concrete base having the greatest yardage. Concrete pavements were also introduced and may solve the problem of our hillside pavements.

For further detailed information regarding the different features I beg to refer you to the subsequent detailed report.

Very respectfully,

M. M. O'SHAUGHNESSY,
City Engineer.

BOULEVARDS, STREETS AND HIGHWAYS.

The status of San Francisco's street and boulevard development is well summarized in this statement contained in the recent volume, "California Highways," by Ben Blow, manager of the Good Roads Bureau, California State Automobile Association:

"The City and County of San Francisco, small in area and thickly settled throughout, with many manufacturing and commercial enterprises, which supply an enormous burden of heavy hauling, naturally finds its main traffic problems involved in the construction and maintenance of city streets rather than of roads.

"These problems, it may be said, are being intelligently met and mastered, even the destruction caused by the fire and earthquake of 1906 scarcely seeming to interrupt progress; and compared with other big cities of the United States, San Francisco stands well up in its street development, having as well approximately 20 miles of purely scenic boulevards.

"In so far as its boulevard development is concerned, however, the citizens of San Francisco may well be pardoned if they express enthusiastic pride, for, in spite of the limited area of the city, there have been scenic boulevards developed which compare favorably with the most famous of the United States—the Twin Peaks drive perhaps ranking above all others in variety of interest. * * * "

The rapid increase of automobile utilization demanded the improvement of the city's thoroughfares and the addition of numerous paved avenues for motor vehicle traffic. This traffic in turned provided some of the necessary funds for boulevard construction. Under the provisions of the Motor Vehicle Act passed by the State Legislature May 31, 1913, provision is made for the registration and payment of license fees for motor cars, and also that all fees or other moneys paid to or collected by the State Treasurer under the provisions of this act shall be placed in the Motor Vehicle

Funds. One-half of the net receipts (the balance after expenses of administration and enforcement of this act are deducted) are returned to the counties from which received (as determined by the residence of license owners) and placed by each county in a County Road Fund, the moneys so received to be expended by said counties exclusively in the construction and maintenance of roads, bridges and culverts.

Since the establishment of this fund by the City and County of San Francisco the State has contributed from the funds collected under the Motor Vehicle Act the sum of \$781,233.53 and the city has added to this \$113,500.00.

At the beginning of the past fiscal year the City Engineer's department was reduced in size due to curtailment of the budget appropriation by the Board of Supervisors. However, an unusually large street repair program involving an expenditure of some \$320,220 for the last fiscal year placed many duties on the working force of this department, as all street plans having to do with such reconstruction are now prepared by this department. In the list of streets for which reconstruction plans were prepared many difficult problems arose due to changes in street levels and the extremely high value of the adjacent property.

During the past fiscal year the following important units of the highway and boulevard system were developed:—The Great Highway, Circular Avenue, Monterey Boulevard, Parker Avenue, portion of the Market Street Extension and Townsend Street.

Great Highway:

In the preparation of the plans for paving the Great Highway particular attention was given to the design of the crown grades and cross-section. South from Lincoln Way the old macadam pavement resting on a sand foundation was utilized in so far as possible as a base, since the years of travel that it had carried compacted it to such a degree as to make it suitable for a foundation. The crown was reduced consid-

erably from ordinary practice so as to minimize the effect of skidding, and yet give good drainage. On this portion the asphaltic concrete top is 2 in. thick. Between Lincoln Way and the Esplanade a 1½ in. asphaltic concrete top is laid on a 6 in. concrete base. Between Fulton Street and the north end of the Esplanade a commodious parking area has been provided for motorists.

A contract for paving the easterly portion (45 ft. wide) of the Great Highway from the southerly line of Fulton Street to a point 438 feet northerly from the northerly line of Balboa Street, a total length of 1880 feet, was awarded on January 16, 1920, to the Fay Improvement Company and completed and accepted on May 26, 1920. For paving the easterly portion (43 ft. wide) of this highway from Fulton Street to Lincoln Way contract was awarded to the Raisch Improvement on May 21, 1920. This is still in course of construction.

Circular Avenue and Monterey Boulevard:

This pavement involved a very careful grade study, involving the intersections of San Jose Avenue, Joost Avenue, Diamond Street, Gorham Street and the right of way of the Southern Pacific. A suitable approach to the Bernal Cut, the city's future main level highway route, was involved. Contract for the asphaltic concrete pavement, concrete curbs, culverts and catch basins was awarded to the Fay Improvement Company on October 27, 1919, and completed February 20, 1920.

Parker Avenue, St. Rose's Avenue, McAllister Street:

The grading and paving of this street affords a short cut to Golden Gate Park from the district north of the old cemeteries and connects also with Geary Street, one of the main thoroughfares of the city. This contract involved the moving of 2,000 cu. yds. of earth and laying of 60,000 sq. ft. of asphaltic concrete pavement and 8,500 sq. ft. of brick. The work was accepted from the contractors, Blanchard, Crocker & Howell, on September 26, 1919.

Holly Park Circle:

The improvement of this street encircling Holly Park has made accessible one of the city's beauty spots as well as added to the aesthetic and commercial value of the surrounding district. This work was performed by Clark and Henery under public contract, the city as owner of the park, school and firehouse property fronting on the improvement paying about one-half of the cost. The contract was awarded February 7, 1919, completed and accepted August 20, 1919, and included 85,000 sq. ft. of 2 in. asphalt on 6 in. concrete base and 3900 feet of concrete curb.

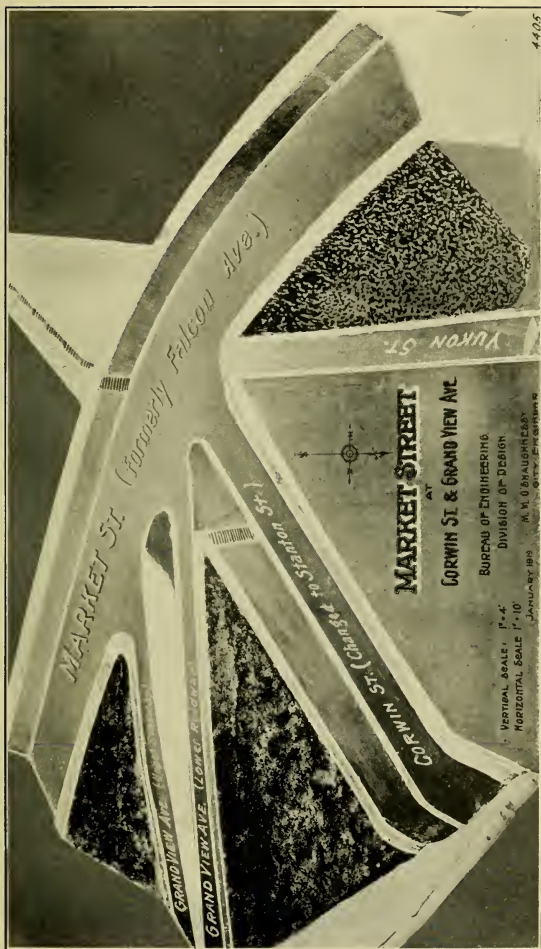
Sloat Boulevard, northerly strip from Great Highway to Fortieth Avenue produced.

This contract, awarded on June 4, 1920, to the Fay Improvement Company, is the second unit to provide for the paving of Sloat Boulevard to the full proposed width of 135 feet, another section having been completed in connection with the improvement of St. Francis Circle.

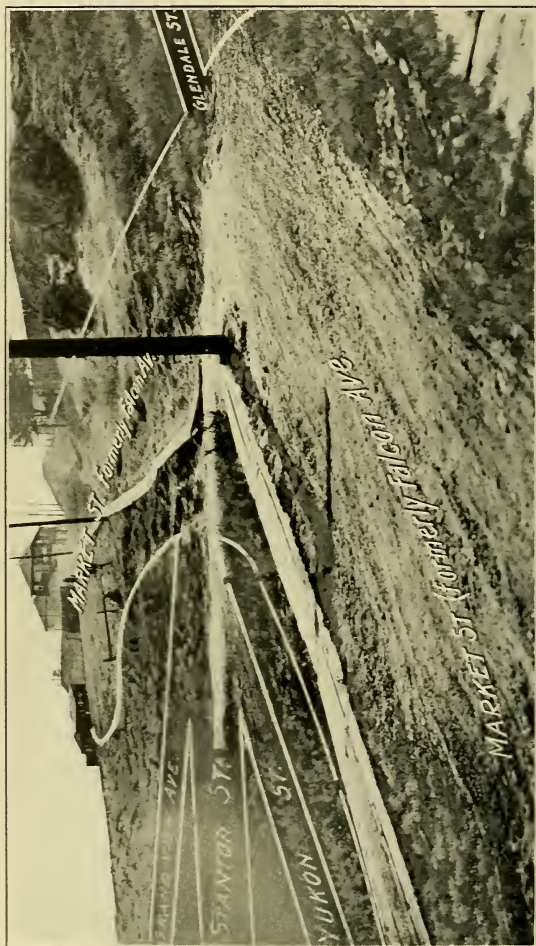
This contract provides a 30-foot paved strip just north of the 35-foot right of way of the United Railroads. A similar strip has already been paved on the south of the tracks, so there will be two 30-foot roadways with 35 feet for car tracks in the center and 20 feet on each edge for sidewalks and parking strips.

Market Street Extension, Collingwood Street to Ord Street with an extension to Eighteenth Street.

The work under this contract has been practically completed, but several details of minor importance yet remain to be done. This easterly section of the Market Street Extension and Corbett Road project lies over the double tube section of the Twin Peaks Tunnel and directly connects with the upper end of Market Street. A 90-foot right of way for this road was purchased by the city at the time of the construction of the tunnel and under this contract



Clay model. One of the methods used in making a study of the intersection of Falcon Avenue, Grand View Avenue, Stanton Street, Yukon Street and Glendale Street preliminary to the establishing of grades thereon.



On line of the extension of Market Street, showing existing conditions at the intersection of Falcon Avenue, Grand View Avenue, Stanton Street, Yukon Street and Glendale Street.

a 74-foot roadway has been paved, leaving 8-foot sidewalk space along each side. Approximately 85,000 square feet of 1½-in. asphaltic concrete surface on a 6-in. concrete base have been laid by the contractors, the Raisch Improvement Company.

Bids will soon be called for improving another section of the Market Street Extension which is the connecting link between Corbett Avenue and the central section of the city. The improvement of this boulevard from the easterly termination of Mono Street to Twenty-fourth Street will provide a completely paved highway from the Ferry Building to the beach, around the Twin Peaks, via Corbett Road, Portola Drive and Sloat Boulevard. There will remain to be improved the section of the Market Street Extension from Mono Street to Ord Street, but until all rights of way are procured and the work completed, a temporary but well paved route over Eighteenth Street and Faleon Avenue from Hattie Street to Caselli Avenue will connect up the completed sections of the drive.

PROPOSED WORK.

Great Highway Improvement:

Plans have been prepared and bids received for the paving of the westerly side of the Great Highway from Balboa Street to Cabrillo Street, which will complete the paving of the proposed roadway 150 feet wide between Cabrillo Street and the north end of the Esplanade. The work now being done under another contract will complete an 83-foot paved strip from Cabrillo Street to Lincoln Way—eventually this section will also be paved to the full width of 150 feet. Beyond Lincoln Way the upper roadway to Sloat Boulevard has a 30-foot strip paved and it is proposed also to improve and pave the lower road. Plans are now being prepared for widening and paving Point Lobos Avenue, the road skirting Sutro Heights and forming the connecting link between the

Great Highway and Geary Street. With the completion of this work San Francisco will possess a marine drive 3 miles in length of most up to date engineering and construction, which will acquire the same world-wide fame attached to the Twin Peaks Drive and other local highways.

Sky Line Boulevard:

Under authority of an act passed by the State Legislature in 1917, the counties of San Francisco, San Mateo, Santa Clara and Santa Cruz joined together in forming a joint highway district for the purpose of constructing the proposed Sky Line Boulevard between San Francisco and Santa Cruz. The cost of construction is to be borne from the State Highway Bond issue of 1919. A reconnaissance survey has been made and rights of way are now being procured, the money for which must be raised by the highway district.✻

The general route of the project will start from Sloat Boulevard and follow the shore of Lake Merced, gradually ascending to meet the present Half Moon Bay Road about a mile west of Colma, thence proceeding along by the Spring Valley Lakes to the summit of the San Mateo-Half Moon Bay Road, thence following the divide to the summit and farther south connecting with the Saratoga-Big Basin Road. From this point the boulevard can follow the main crest of the mountains to the summit, connect with the Los Gatos-Santa Cruz State Highway over which it can proceed to Santa Cruz and Watsonville, or proceed over the State Park Road and Empire Grade to Santa Cruz, thence to Watsonville.

A boulevard over this route (115 miles in length from San Francisco to Watsonville) would appropriately be named the "Sky Line Boulevard," for it would follow the sky line along the crest of the ridge from Lake Merced to Santa Cruz Mountains. Rising from sea level to an elevation of 2800 feet. it will be the most interesting scenic route of the State, with

MAP
OF THE
CITY & COUNTY OF
SAN FRANCISCO

BOULEVARD SYSTEM

AND ALL OTHER STREETS, ALLEYS, AND
WAYS

AS THEY EXISTED
ON JANUARY 1, 1890
AND AS THEY ARE
PROPOSED TO BE
CHANGED



PACIFIC OCEAN

GOLDEN GATE

PRESIDIO

U.S. MILITARY RESERVATION

LINCOLN PARK

LAUREL HILL CEMETERY

CALVARY CEMETERY

MAHON CEMETERY

GOLDEN GATE PARK

RESERVATION

LAUREL HILL CEMETERY

CALVARY CEMETERY

MAHON CEMETERY

LAUREL HILL CEMETERY

CALVARY CEMETERY

MAHON CEMETERY

LAUREL HILL CEMETERY

CALVARY CEMETERY

MAHON CEMETERY

LAUREL HILL CEMETERY

CALVARY CEMETERY

MAHON CEMETERY

LAUREL HILL CEMETERY

CALVARY CEMETERY

MAHON CEMETERY

LAUREL HILL CEMETERY

CALVARY CEMETERY

MAHON CEMETERY

LAUREL HILL CEMETERY

CALVARY CEMETERY

MAHON CEMETERY

LAUREL HILL CEMETERY

CALVARY CEMETERY

MAHON CEMETERY

LAUREL HILL CEMETERY

CALVARY CEMETERY

MAHON CEMETERY

MAP

OF THE

CITY & COUNTY OF

SAN FRANCISCO

1920

BOULEVARD SYSTEM

H.M.O'SHAUGHNESSY, CITY ENGINEER

LEGEND

Boulevards Completed

Macadamized Boulevards

Boulevards Proposed

BAY

OF

SAN

FRANCISCO

INDIA BASIN

WESTERN DEVELOPMENT COMPANY

RANCHO LAGUNA DE LA MERCED

LAGUNA DE LA MERCED

U.S. MILITARY RESERVE

BALBOA PARK

DOHNEY TRACT

views of the Pacific Ocean, San Francisco Bay, Santa Clara Valley and Monterey Bay.

There is urgent need of another route down the Peninsula to relieve the constant and increasing traffic congestion along the State Highway. The Sky Line Boulevard would serve in this respect and would also make accessible a splendid region for residential development.

SEWER SYSTEM.

Euclid Avenue Sewer:

The construction of a reinforced concrete sewer in Euclid Avenue, Cornwall Street and Arguello Boulevard from Palm Avenue to Second Avenue, which was described in the last Annual Report, has been completed and was accepted on October 17, 1919.

Another step in remedying the problems of caring for the storm flows throughout the Richmond District was taken by extending the reconstruction of the sewer in Euclid Avenue from Palm Avenue to Parker Avenue. 320 lineal feet of 2-ft.x3-ft. reinforced concrete sewer and 670 feet of pipe sewer were constructed under a contract awarded on September 10, 1919, and accepted February 6, 1920.

Sunnyside Creek Sewer:

In order to care for the drainage and sewerage from the slopes of Sunnyside Creek between Joost Avenue and Melrose Street an ironstone pipe sewer was constructed. Rights of way were procured and the sewer completed under contract.

Canal Street Sewer:

A contract for the construction of the first section of the Canal Street sanitary sewer, including approximately 900 feet of 24-inch pipe sewer and a concrete diversion structure, was awarded on June 3, 1920.

The sewer is designed to carry the dry weather flow of the Islais Creek from Mission Street past the built-up College Homestead Tract.

This construction was imperative from a sanitary and health standpoint in view of the fact that the sanitary flow from Islais Creek is not as yet diverted to the North Point Main. Although this sewer is built to serve as a strictly sanitary sewer, it can at a later date form part of and conform to the permanent separate system of sewerage for the Islais Creek District.

Presidio Sewer:

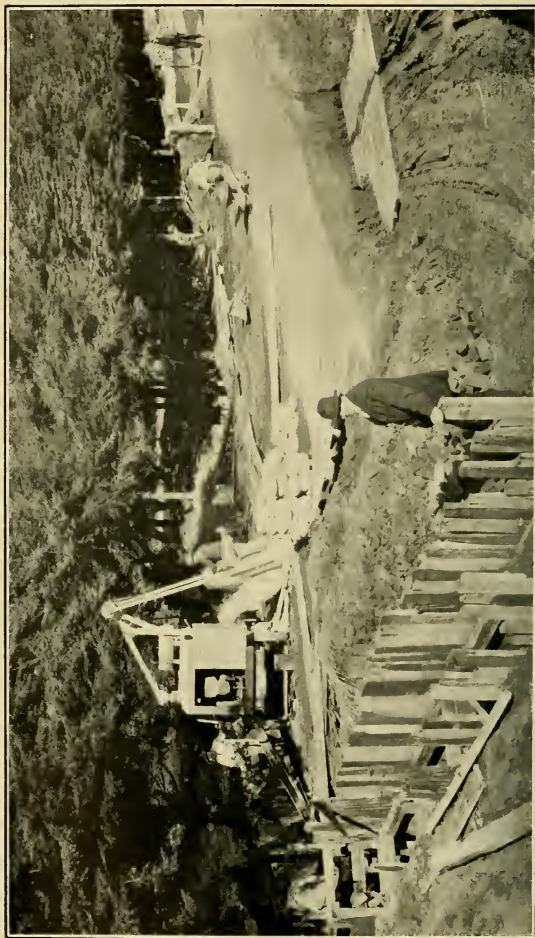
The construction of approximately 1137 feet of 2' 6" x 3' 9" reinforced concrete sewer in the Presidio Military Reservation from Locust Street northeasterly to connect with an existing brick tunnel, thence to Union Street, was contracted for on October 31, 1919. This sewer replaces an old 18-inch pipe sewer which has proved inadequate to take care of the storm flow periods. Frequent breakages have occurred on this old sewer and considerable damage both to the sewer itself and the adjacent land resulted in constant recurring expenditures. This contract is now complete and the sewer ready to take the next storm flow that occurs.

Proposed Work:

Plans and specifications for the construction of about 1,700 feet of 15 and 21 inch sanitary sewer in Beach Street between Polk and Leavenworth Streets have been prepared and the awarding of a contract awaits the beginning of the Aquatic Park improvement. This sewer construction is part of the change which will be forced upon the drainage district bordering the northerly end of Van Ness Avenue by the proposed Aquatic Park construction. This latter improvement will require the diversion of the existing sanitary outlets to the North Point Main, discharging at the foot of Grant Avenue into the channel of the main tidal currents.

Among other proposed work are the replacement of an old and inadequate 16-inch sewer in Stanyan Street by a 2-ft.x3-ft. concrete sewer, and the extension of the Canal Street sanitary sewer.

There are also other sections within the Richmond District that from observation indicate that reconstruction must shortly be done and a thorough and systematic plan to eliminate this condition is gradually being conducted by this office.



Sewer in course of construction in the Presidio Reservation.

Sewer Drainage Maps:

To determine the location, size and character of the main sewers for each of the districts into which the city is divided by its topographical features, and in turn to determine the size and grade for the many laterals that are constructed each year by public and private contracts, complete drainage maps have been prepared in twenty-three sections so that the necessary tabulations can be carried out to effect a gradual convergence to the main sewers. These maps were made about 1907. Since that date numerous changes have occurred both in the alignment of streets, street names, grades and the opening of new tracts. Furthermore, the development of some of the outlying tracts of a certain drainage district previous to the building up of the districts along the line of natural outfall has resulted in forced changes of design or channels of flow to provide relief for the outlying district. During the past year twenty-three of these sheets were revised and the computations that go with them corrected.

MISCELLANEOUS CONSTRUCTION.

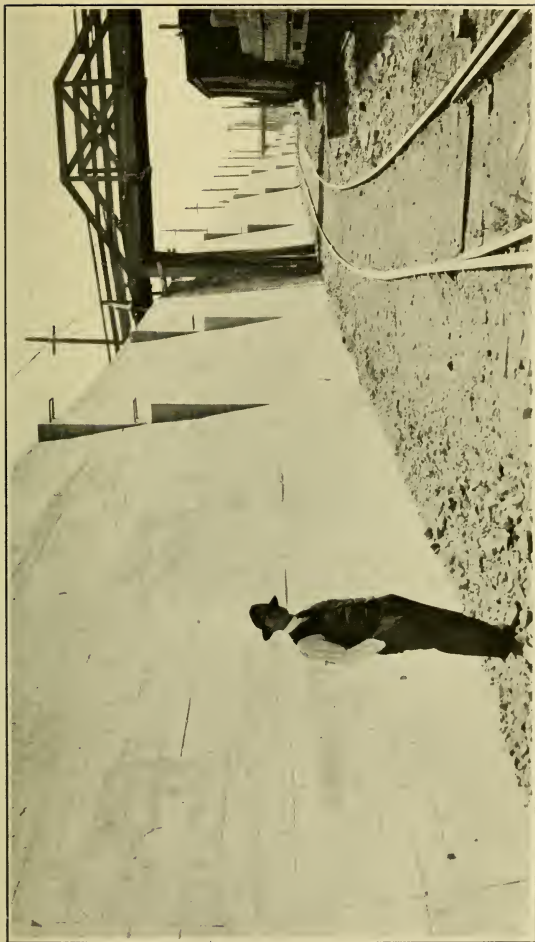
Army Street and Evans Avenue—Preliminary Improvements

One of the first problems to be solved in city development is the location and permanent improvement of properly graded highways and the interconnection of all industrial, business and residence sections. This office has given this type of improvement its constant attention, recognizing the fact that the city must furnish the necessary permanent improvements to facilitate transportation before private capital will invest or develop within its boundaries.

Army Street between San Bruno Avenue and Third Street has for years been recognized as the best route between the lower Mission District with its business and heavily populated residence section, and the industrial and waterfront sections traversed by Third Street. Army Street is located at the base of the southern slope of the Potrero Hills, which form a natural barrier to traffic between Potrero Avenue and Kentucky Street south of Seventeenth Street. It also borders the Islais Creek section which is destined to be one of San Francisco's most prosperous industrial districts.

The improvement of Army Street took definite shape in 1918 when a contract was let to grade the street between San Bruno Avenue and Third Street. This contract called for 15,000 cu. yds. of excavation and when completed left Army Street with a maximum grade of less than 3 per cent. The width of this street, being 66 feet, was considered to be too narrow and the thoroughfare was widened to 75 feet and the sidewalks narrowed to a width of 8 feet.

In 1918 the United Railroads were permitted, as a war measure, to construct a double track street railway line over Army Street to connect with their Third Street lines and thus facilitate labor transportation to the Union Iron Works. At present approximately 4,000 men are transported by this company over Army Street every day and these men reach their homes from 15 to 30 minutes sooner than was possible before this improvement.



Army Street Retaining Wall.

Between Wisconsin and Mississippi Streets, Army Street is located between the walls of the Potrero Hills as left by the Ocean Shore Railroad. The south property line of Army Street at this location also is the north line of the Ocean Shore Railroad right of way. For approximately 1,800 lin. ft. the United Railroads tracks on Army Street are from 1 foot to 28 feet above the tracks of the Ocean Shore Railway. This condition made the further improvement of Army Street impossible until some means of supporting the necessary fill on the south side of the street was provided and at the same time the necessary protection furnished to the Ocean Shore tracks. This improvement has been accomplished by the construction of a retaining wall of the semi-gravity type, ranging in height from 30 feet to 3 feet and of a total length of 1,253 lineal feet.

Contract for the retaining wall was awarded on December 10, 1919, for \$40,257.00, and is practically completed, the necessary fill behind the wall of approximately 7,000 cu. yds. being in place. The finished wall contains 2,755 cu. yds. of concrete and 52 tons of reinforcing steel.

Specifications for permanent surface improvements, paving, sewers, catchbasins, etc., are now being drawn up, and, with the work proposed on Evans Avenue, will connect new industrial districts with the other sections of the city. The proposed work on Evans Avenue will provide direct egress from the northwesterly section of the Islais Creek district and also offer a direct connection to Hunters Point Boulevard from Potrero Avenue. At present there is in force a contract for cutting through Evans Avenue from Army Street to Tulare Street and to date over 20,000 cu. yds. of earth and rock have been removed. The contemplated improvements will include the paving of Evans Avenue and the construction of a reinforced concrete bridge over the Ocean Shore tracks.

Esplanade Public Comfort Station:

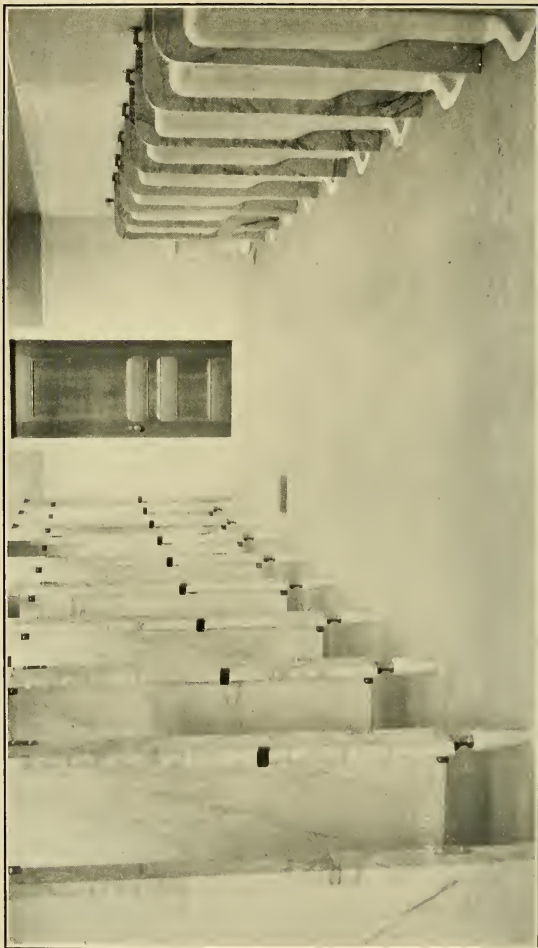
Plans and specifications have been prepared and a contract let for the construction of a \$31,600 public comfort station at the Ocean Beach Esplanade between Balboa Street and Cabrillo Street. This contract is well under way and the station is about ready to receive the interior finishing. This will provide the first large commodious, well lighted public convenience station of its kind in the city and will be well in keeping with its location. In order that the present promenade be unobstructed and also to avoid the necessity upon the part of the public of crossing the heavy traveled Great Highway it was decided to place this comfort station beneath the area to be occupied by the sidewalk of the next section of the Esplanade that will be constructed.

This station measures over all $92\frac{1}{2} \times 21$ feet and 10 feet interior height. It is divided into four sections, consisting of men's toilet compartment measuring 35×14 feet, ladies' toilet compartment measuring 29×14 feet; ladies' rest room, $18\frac{1}{2} \times 17\frac{1}{2}$ feet; and a workroom, $18\frac{1}{2} \times 7$ feet, in which are located the mechanical equipment and work bench.

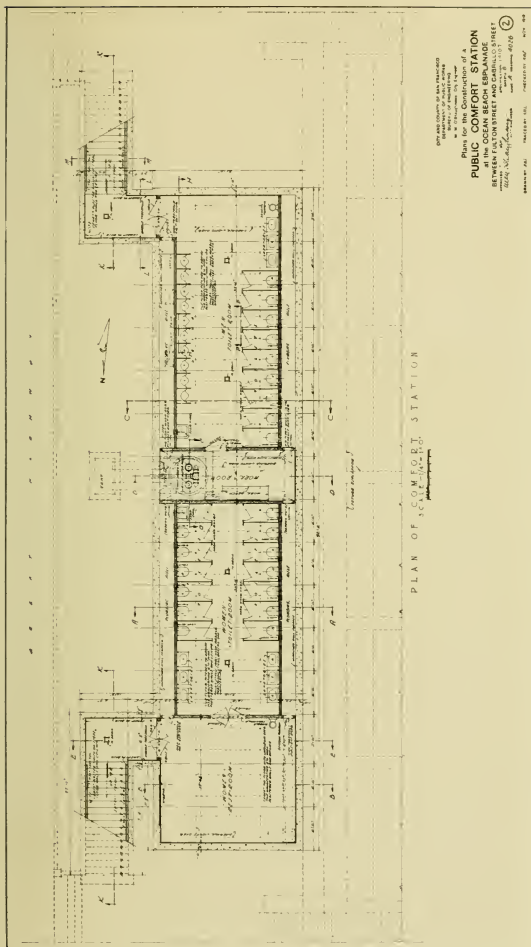
In order to make use of our existing sewers the station is equipped with a duplex automatic sewage pumping unit equipped with all necessary automatic controls and high water alarm. This will elevate the sewage from a center sump within the station to the existing sewer located in the Great Highway.

The men's toilet proper provides for nine toilets, ten urinals, three lavatories and one sink. The women's toilet room provides for thirteen toilets, six lavatories and one sink.

Adequate ventilation is taken care of by the installation of two 25-inch Universal exhausters direct connected to electric motors. These fans are capable of changing the air within the station every five minutes. They are suspended from the ceiling and are so arranged that either one or both fans may exhaust from all parts of the structure. The ventilating



Ocean Beach Comfort Station. Interior View.



Sectional Plan of Public Comfort Station in course of construction at the Ocean Beach Esplanade.

ducts are connected to the plumbing aisles and the plumbing aisles are vented to each toilet compartment.

The plumbing and fixtures are of the most modern type. All piping is concealed in plumbing aisles so that it is readily accessible for overhauling, at the same time inaccessible to the public. All fixtures are of the suspended type and kept off the floor, allowing for convenient flushing of the floors of the station at any time.

The floors are of silver gray hexagon tile. Walls up to a point 6 feet from the floor are of white glazed tile. All corners are fitted with sanitary curve tile. Ceiling and upper part of walls are plastered and painted a suitable color. Toilet partitions and all mullions and braces are of Columbian marble. A minimum amount of metal fixtures is exposed.

Ample light is provided for by the installation of side-walk lights, and in addition thereto the station has been completely wired and fitted with lighting fixtures.

Fender Piling at Third Street Channel Bridge:

Plans and specifications were prepared for the construction of a system of fender piling to protect the piers of the Third Street Bridge over the channel waterway.

This work is now completed and will afford a much needed protection to the piers which were in constant danger of being injured by passing boats. At times vessels have considerable difficulty in passing between the piers of the bridge due to the occasional heavy winds prevailing in this locality.

A modification of the general method of constructing fenders has been used at this location. In addition to a double row of fender piling, there has also been incorporated a system of diagonal fender strips which will serve to take the first blow from the steamer and in most cases prevent serious damage to the piling. These strips are so attached that the replacement of same can be done at any low tide, thereby cutting down the heavier expense entailed by the replacement of the piling.

TABLE 1. SUMMARY OF RESULTS			
Run	Time	Distance	Speed
1	1.00	1.00	1.00
2	1.00	1.00	1.00
3	1.00	1.00	1.00
4	1.00	1.00	1.00
5	1.00	1.00	1.00
6	1.00	1.00	1.00
7	1.00	1.00	1.00
8	1.00	1.00	1.00
9	1.00	1.00	1.00
10	1.00	1.00	1.00
11	1.00	1.00	1.00
12	1.00	1.00	1.00
13	1.00	1.00	1.00
14	1.00	1.00	1.00
15	1.00	1.00	1.00
16	1.00	1.00	1.00
17	1.00	1.00	1.00
18	1.00	1.00	1.00
19	1.00	1.00	1.00
20	1.00	1.00	1.00
21	1.00	1.00	1.00
22	1.00	1.00	1.00
23	1.00	1.00	1.00
24	1.00	1.00	1.00
25	1.00	1.00	1.00
26	1.00	1.00	1.00
27	1.00	1.00	1.00
28	1.00	1.00	1.00
29	1.00	1.00	1.00
30	1.00	1.00	1.00
31	1.00	1.00	1.00
32	1.00	1.00	1.00
33	1.00	1.00	1.00
34	1.00	1.00	1.00
35	1.00	1.00	1.00
36	1.00	1.00	1.00
37	1.00	1.00	1.00
38	1.00	1.00	1.00
39	1.00	1.00	1.00
40	1.00	1.00	1.00
41	1.00	1.00	1.00
42	1.00	1.00	1.00
43	1.00	1.00	1.00
44	1.00	1.00	1.00
45	1.00	1.00	1.00
46	1.00	1.00	1.00
47	1.00	1.00	1.00
48	1.00	1.00	1.00
49	1.00	1.00	1.00
50	1.00	1.00	1.00
51	1.00	1.00	1.00
52	1.00	1.00	1.00
53	1.00	1.00	1.00
54	1.00	1.00	1.00
55	1.00	1.00	1.00
56	1.00	1.00	1.00
57	1.00	1.00	1.00
58	1.00	1.00	1.00
59	1.00	1.00	1.00
60	1.00	1.00	1.00
61	1.00	1.00	1.00
62	1.00	1.00	1.00
63	1.00	1.00	1.00
64	1.00	1.00	1.00
65	1.00	1.00	1.00
66	1.00	1.00	1.00
67	1.00	1.00	1.00
68	1.00	1.00	1.00
69	1.00	1.00	1.00
70	1.00	1.00	1.00
71	1.00	1.00	1.00
72	1.00	1.00	1.00
73	1.00	1.00	1.00
74	1.00	1.00	1.00
75	1.00	1.00	1.00
76	1.00	1.00	1.00
77	1.00	1.00	1.00
78	1.00	1.00	1.00
79	1.00	1.00	1.00
80	1.00	1.00	1.00
81	1.00	1.00	1.00
82	1.00	1.00	1.00
83	1.00	1.00	1.00
84	1.00	1.00	1.00
85	1.00	1.00	1.00
86	1.00	1.00	1.00
87	1.00	1.00	1.00
88	1.00	1.00	1.00
89	1.00	1.00	1.00
90	1.00	1.00	1.00
91	1.00	1.00	1.00
92	1.00	1.00	1.00
93	1.00	1.00	1.00
94	1.00	1.00	1.00
95	1.00	1.00	1.00
96	1.00	1.00	1.00
97	1.00	1.00	1.00
98	1.00	1.00	1.00
99	1.00	1.00	1.00
100	1.00	1.00	1.00

the
En-
d on

Fol-
eva-
de-

] ns
ed
ng
ial

—

—

—

—

/

be-
ring
cov-

CURRENT CONTRACT DATA, 1919-20

No.	LOCATION	Contractor	Date of Award	Date Completed	Percent Complete	Amount of Completed Contract	Amount Expended to June 30, 1920	Fund
BOULEVARDS, PAVING AND GRADING								
	San Jose Ave., Circular Ave., Joost Ave. and Diamond St.	Fay Improvement Co.	10/27/19	2/20/20	100	\$ 8,308.49	\$ 7,065.00*	County Roads
	Market St. Extension, Collingwood to Ord St.	Raisch Improvement Co.	1/9/19		95	37,606.73	32,968.13	County Roads
	Great Highway, E. ½, Fulton St. northerly	Fay Improvement Co.	1/16/20	5/26/20	100	14,417.96	14,417.96	County Roads
	Great Highway, Esplanade to Sloat Blvd.	Blanchard, Crocker & Howell	4/28/19	8/20/19	100	80,221.46	80,221.46	County Roads
	Great Highway, E. ½, Fulton to Lincoln	Raisch Improvement Co.	5/21/20		5	(36,072.00)		County Roads
	St. Francis Circle and Sloat Blvd.	Blanchard-Brown Co.	12/18/18	7/18/19	100	21,357.56	21,357.56	County Roads and Mun. Ry
	Parker Ave., St. Rose's to McAllister	Blanchard, Crocker & Howell	2/26/19	9/26/19	100	32,617.60	32,617.60	County Roads
	Teath St., Division St. to Potrero Ave.	Flynn & Treacy	3/3/19	7/9/19	100	2,986.70	2,986.70	County Roads
	Holly Park Circle	Clark & Henery	2/7/19	8/20/19	100	31,745.25	15,005.81†	General Fund
	Sloat Blvd., N. ½, Great Highway to 40th Ave.	Fay Improvement Co.	6/4/20			(23,377.40)		County Roads
	Evans Ave. Napoleon to Army	J. P. Holland	1/23/20		80	\$ 685 cu.yd.	0,370.80	Gen. Fund and Spec. Ass'm't
	Corbett Ave., Mattie to Ord St.	State Improvement Co.	3/15/20		65	(1,816.96)		County Roads
SEWERS								
	Euclid Ave., Cornwall St. and Arguello Blvd.	Hickey & Harmon	5/28/19	10/17/19	100	9,032.56	9,032.56	1908 Sewer Bonds
	Euclid Ave., Palm Ave. to Parker Ave.	T. D. Harney	9/10/19	2/11/20	100	7,041.94	7,041.94	General Funds
	Presidio Reservation, Locust to Union St.	Hickey & Harmon	10/31/19	2/11/20	100	12,655.91	12,655.91	General Funds
	Canal St., Mission St. easterly	Burnham Plumbing Co.	5/24/20			(4,975.50)		General Funds
	Sunayside Creek Sewer, Joost Ave. to Melrose St.	T. D. Harney	2/11/20	5/14/20	100	1,487.60	1,487.00	General Funds
MUNICIPAL RAILWAYS								
108	Furnishing and installing electric passenger elevator	Otis Elevator Co.	11/29/18	8/20/19	100	\$15,570.00	\$15,570.00	Municipal Railway
111	Relocation: Union St. line, Franklin St. to Van Ness Ave.	Healy-Tibbitts Construction Co.	6/2/19	9/12/19	100	23,044.92	23,044.92	Municipal Railway
113	Furnishing and delivering track special work	U. S. Steel Products Co.	4/14/19	8/20/19	100	15,938.00	15,938.00	Municipal Railway
115	Furnishing and delivering wood ties	J. R. Hanify Co.	3/31/19	6/18/19	100	7,803.50	7,803.50	Municipal Railway
119	Installing trolley poles and wire, Union St. relocation	Eccles & Smith	6/2/19	10/22/19	100	1,404.47	1,404.47	Municipal Railway
120	Storage spur, Polk St. between Geary and Post Sts.	C. B. Eaton	9/10/19	10/22/19	100	8,916.65	8,916.65	Municipal Railway
121	Center entrance street car	A. Meister & Sons Co.	10/24/19		75	(12,500.00)	0,901.06	Municipal Railway
122	Furnishing and delivering track special work	U. S. Steel Products Co.	12/12/19		90	(2,280.00)		Mun. Ry. Depreciation
123	Furnishing and mounting automobile bus hodies	A. Meister & Sons Co.	4/26/20		25	(6,000.00)		Mun. Ry. Depreciation
MISCELLANEOUS								
	Thrd St. bridge, fender piling	Healy-Tibbitta Construction Co.	11/14/19	3/15/20	100	7,882.77	7,882.77	General Funds
	Lelaie Creek bridge, rock fill	Healy-Tibbitts Construction Co.	12/19/19	6/3/20	100	3,570.51	3,570.51	General Funds
	Army St., Evans to Iowa St., retaining wall	Healy-Tibbitta Construction Co.	12/10/19		80	40,257.00	20,128.50	General Funds
	Aquatic Park beach, Van Ness to Larkin, grading	O. McHugh	5/28/19	7/23/19	100	5,671.06	5,671.06	South Beach Land Fund
	Commercial St. sewage pump station, pump and motor	J. E. O'Mara	10/4/18	9/3/19	100	2,883.00	2,883.00	General Fund
	Ocean Beach convenience station	J. Spargo	3/12/20		35	(31,140.00)	0,700.50	General Fund

Contract amounts in parentheses () are based on estimated quantities.

* Balance paid by Southern Pacific Company.

† Balance paid by private property owners.

PROJECTS.

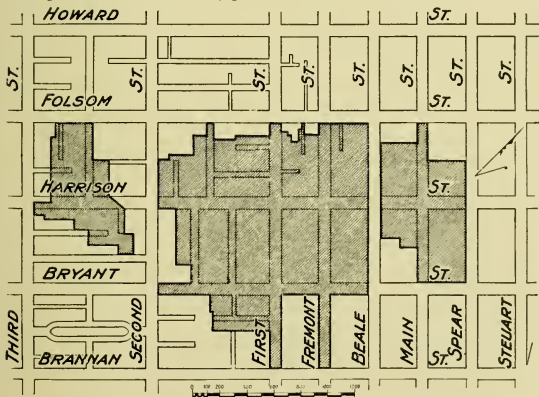
Besides preparing plans and specifications for all of the improvements described in the preceding pages, the City Engineer's office has during the past fiscal year been engaged on the following projects:

Rincon Hill Regrade:

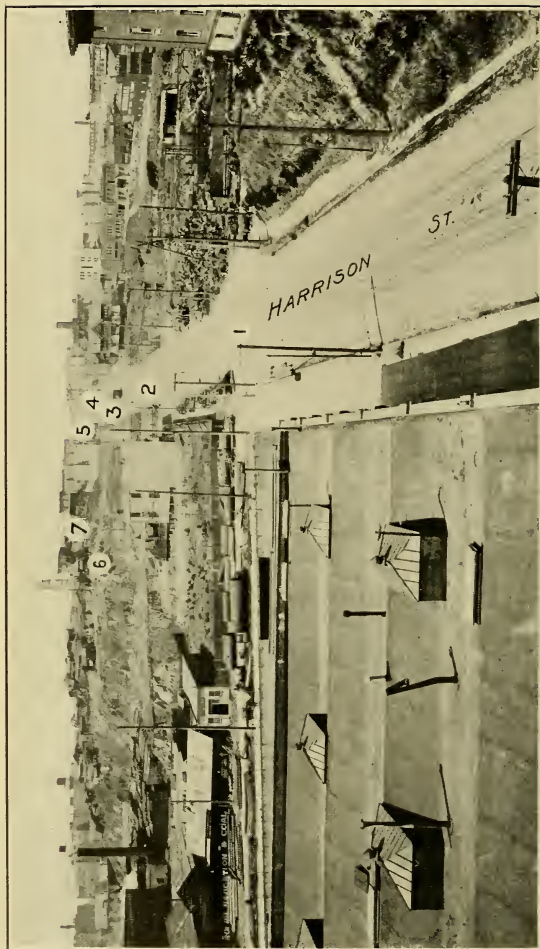
Rincon Hill covers an area of 85 acres, bounded by Folsom, Third, Brannan and Spear Streets. Its summit elevation is 110 feet, while the official grades on the adjacent developed business thoroughfares average 12 feet.

RINCON HILL DISTRICT MAP

The map shows the proposed regrade district for the Rincon Hill project. The district contains 85 acres and will prove one of the most important commercial centers of the city if the proposed idea of cutting down the hill is carried out. The plan will allow of a network of tracks covering the area, additional street car transportation, solid ground for the erection of modern industrial buildings, and broad streets with easy grades.

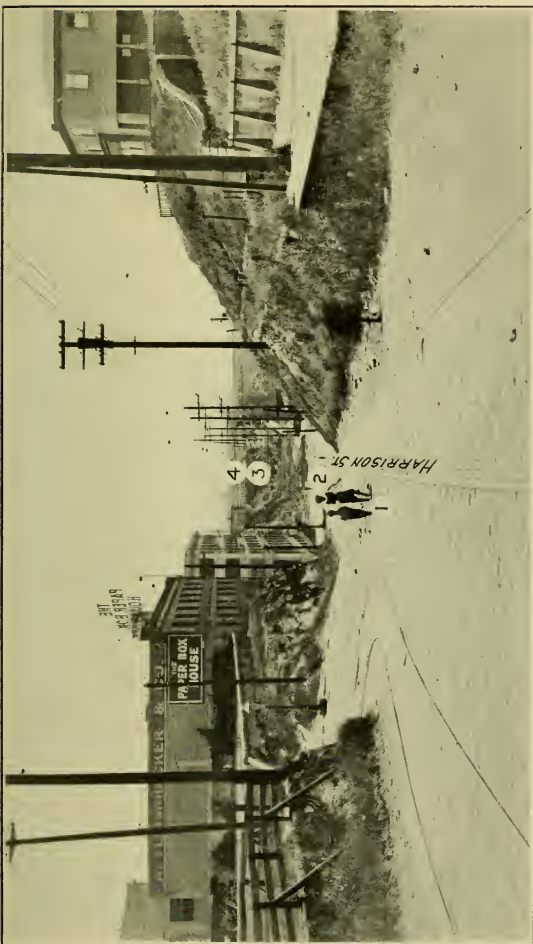


The hill has long been a barrier to transportation between the business section of the city and the manufacturing and water front area south of Market Street. The area cov-



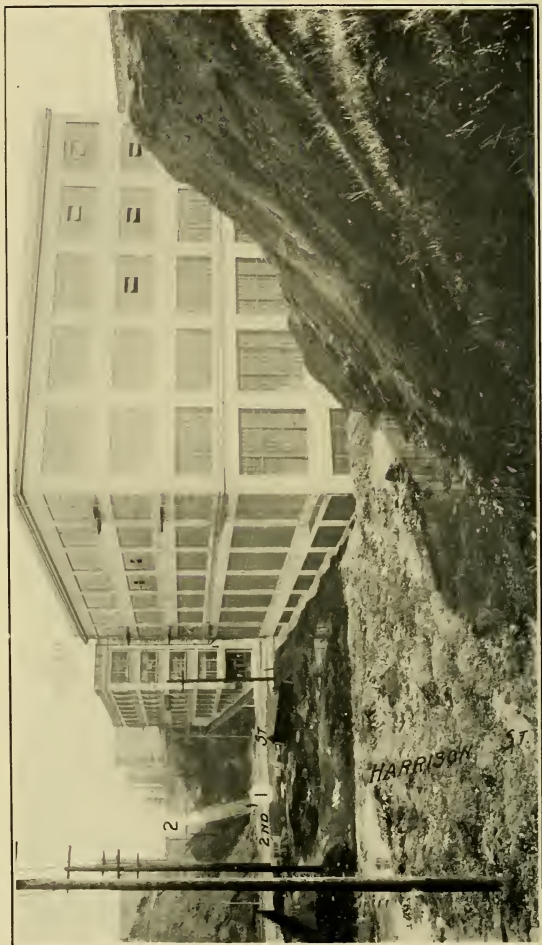
Rincon Hill Regrade Harrison Street looking west from Spear Street.

- (1) Harrison Street at Main. Grade to be lowered 10 feet.
- (2) Harrison Street at Beale. Grade to be lowered 35 feet.
- (3) Harrison Street at Fremont Street. Grade to be lowered 45 feet.
- (4) Harrison Street at Essex. Grade to be lowered 55 feet.
- (5) Harrison Street between Harrison and Bryant Streets. Grade to be lowered 63 feet.
- (6) Fremont Street between Harrison and Bryant Streets. Point of maximum cut on Rincon Hill. Grade lowered 89 feet.
- (7) First Street between Harrison and Bryant Streets. Point of maximum cut on Rincon Hill. Grade lowered 89 feet.



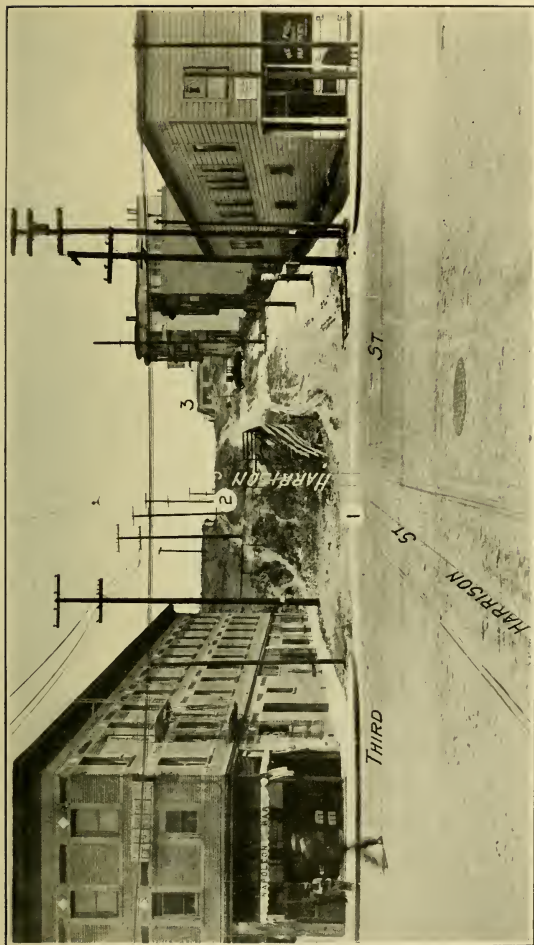
Rincon Hill Regrade. Harrison Street looking west from Essex Street.

- (1) Harrison Street near Essex Street. Grade to be lowered 50 feet.
- (2) Harrison Street at Second Street. Second Street grade to remain same as at present. On the left new buildings are shown erected since spur tracks were laid on Second Street.
- (3) Bluff to be cut 39 feet. A present barrier between Rincon Hill and the industrial district to the west.
- (4) Harrison Street looking west from Third Street.



Rincon Hill Regrade. Harrison Street, east and west of Second Street.

- (1) Second Street grade to remain as at present. Buildings on the right built since the spur tracks have been laid on Second Street.
- (2) Harrison Street at Essex Street. Grade to be lowered 56 feet.



Rincon Hill Regrade. Harrison Street looking east from Third Street.

- (1) Third Street at Harrison Street. Grade remains same as at present.
- (2) Harrison Street at Hawthorne Street. Cut of 40 feet at this point.
- (3) Top of building at southwest corner of Second and Harrison Streets.

ered by Rincon Hill is now occupied by scattered second-class residences. Much of the district is practically waste land, due to the excessive grades, which render what should be a most valuable section, in the very heart of the city, totally unfit for commercial purposes.

The hill adjoins the wholesale and retail business sections of the city—its removal will, therefore, not only provide direct routes for transportation, but also so rapidly enhance property values in the district itself, that regrading the section will prove no burden on the owners of the land affected nor in the proposed assessment district. It is proposed to cut down the hill so that the maximum street grades will not exceed $3\frac{1}{2}$ per cent, and to widen and pave the streets traversing this area. A network of industrial tracks will be run throughout the district when the hill is razed, so that manufacturing plants, warehouses and business institutions will be given direct connection with the wharves and railroads.

Construction in the regraded area will be cheaper than in some of the adjacent territory, due to the fact that the district will be all on solid ground, where piling can be eliminated and foundation costs are comparatively low.

During the past fiscal year the Board of Supervisors approved a change of grade ordinance which will facilitate the procedure for the accomplishment of this project. The ordinance, in addition to providing for change of grade, provided for recommendations by the City Engineer as to side slopes upon abutting properties. This office has compiled most of the data for the regrade problem and is preparing an assessment district that will help defray the cost of the project. Surveys of the entire sections have been made and every lot and improvement located with reference to the regrade. Fifteen regular city blocks and 309 parcels of land are involved. The greatest cut is 89 feet, and there will be a total of 3,000,000 cubic yards of soft rock and clay to be removed.

The best available dump site that would derive a maximum benefit from this material, and for which payment

would most likely be made, is known as the Islais Creek district, situated about 3 or 3½ miles south of Rincon Hill, and consists of 800 acres of tide lands on the South Francisco Bay shore. This section lies in the path of San Francisco harbor development and directly adjoins areas that are now being developed by the California State Harbor Commission. Excellent transportation facilities connect the regrade district with the Islais Creek district.

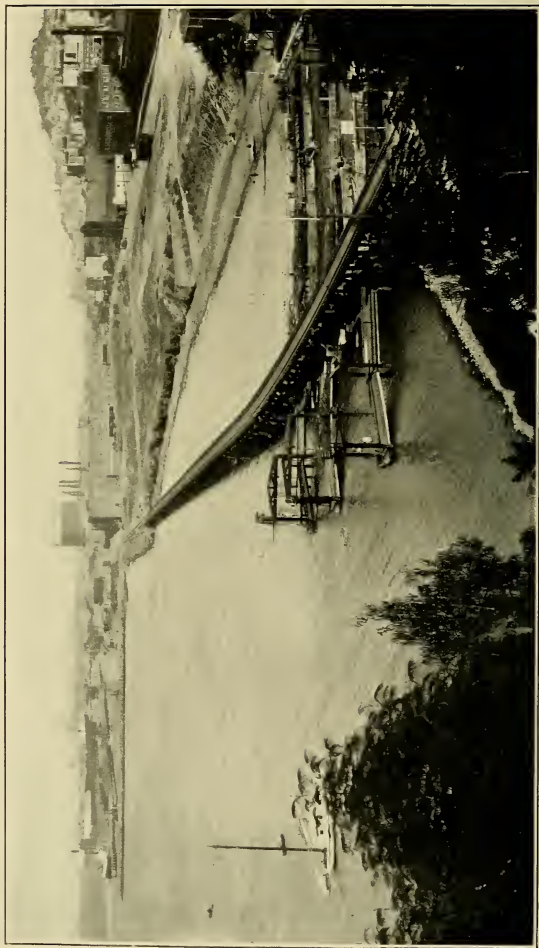
It will take about eighteen months after construction starts to complete this work, with an expenditure of approximately \$4,000,000. At this time land on top of the hill is worth less than \$1.00 per square foot, while at the foot, where industries are gradually encroaching on it by necessity, land is worth up to \$4.00 per square foot.

The assessed value of the real estate within the regrade district is approximately \$1,000,000 and the assessed value of the improvements \$250,000. Fortunately at this time, with one or two exceptions, the more permanent and costly type of structures are around the base of the regrade, and beyond underpinning and extension of footings will not be seriously affected.

The accompanying photograph of Second Street, which bounds the proposed regrade and is lined with fine business structures, in striking contrast to the buildings in the Rincon Hill district, forcibly shows the advantages of the proposed regrade.

Aquatic Park:

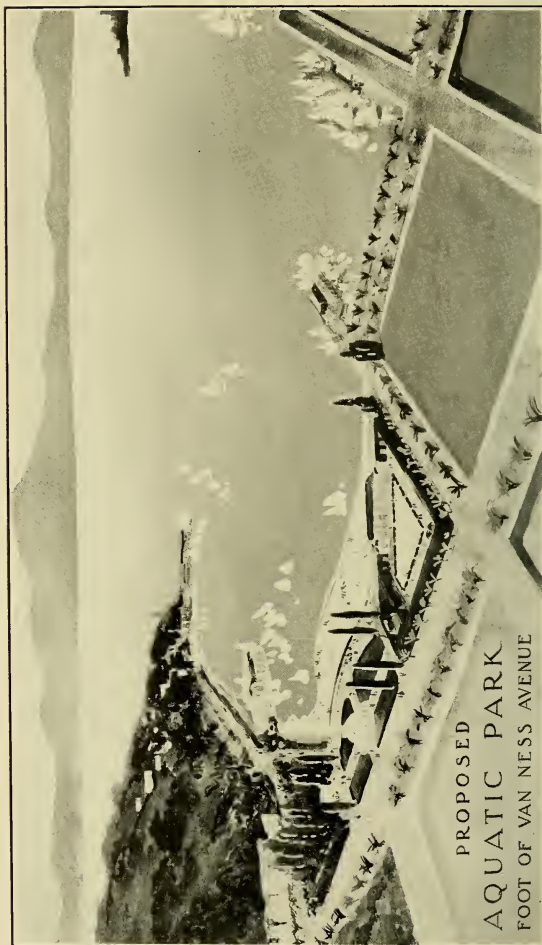
It is proposed to develop the area at the foot of Van Ness Avenue bounded by Van Ness Avenue, Larkin Street, Beach Street and Jefferson Street, together with that which lies to the north of Jefferson Street between Fort Mason and Hyde Street as an aquatic park. For the purpose of stimulating public interest in this development the Board of Public Works has authorized the holding of a competition among architectural draftsmen based on the general requirements



View of the existing cove at the end of Van Ness Avenue to be developed as an Aquatic Park.



One of the first prize plans submitted in the Aquatic Park Contest.



Another of the first prize plans submitted in the Aquatic Park Contest.

of this project and appointed a committee consisting of the following, who will judge the submitted plans: John Reid, Jr., City Architect; Frederick H. Meyer, 742 Market Street; Arthur Brown, Jr., 251 Kearny Street; J. E. Scully, Phelan Building; M. M. O'Shaughnessy, City Engineer.

Complete surveys were made and basic plans prepared by this office for the area covered by this project for the use and guidance of the contestants. The tentative location for the existing Belt Line Railway has already been decided upon and will most likely receive the approval of the Harbor Commission.

A complete sanitary sewer system has been designed to take care of that part of the outfall that now empties into this cove, and as soon as the plan has been decided upon this part of the work will be immediately undertaken.

Investigation of methods and equipment are now being made with reference to the sterilization and filtering of water in connection with the proposed swimming pool, the intention being to use part of the equipment of the existing high pressure pumping station at Fort Mason for this purpose.

City Planning:

A complete map of San Francisco in fourteen sections on a scale of 200 feet to the inch has been prepared and will serve as a foundation for the work of the City Planning Commission. In addition to this base map a complete building survey has been made of the city for the City Planning Commission and additional maps showing lot lines with the location and nature of occupancy of each worked out in color schemes.

These maps are very complete, showing all the new subdivisions, city properties and spur track locations, and have attracted wide attention from the public service corporations and other interested in city development, with the result that numerous requests have been made for copies.

Marin-San Francisco Bridge:

Pursuant to a request from the Board of Supervisors for a preliminary investigation and report on the subject of the proposition of building a bridge across the Golden Gate from Marin County to San Francisco, this office prepared all basic data, soundings, maps, profiles and photographs upon which to base an opinion as to the practicability of the suspension bridge at this location involving a span of approximately 4100 feet.

In this connection it will be of interest to note that one of the foremost bridge engineers of the world, Mr. Gustav Lindenthal, after making a study of the above data, expressed an opinion that such a structure is practical, but, being designed to take care of two rapid transit tracks, four lines of vehicular traffic and two sidewalks, would cost approximately \$56,000,000, not including rights of way or interest charges, and would take about five years to construct.

Special Improvements:

A number of studies have been made and both tentative and final plans prepared for the improvement of certain streets at the request of the property holders thereon, the topography of which will not allow of them being improved by the ordinary grading and paving methods. In the majority of cases these streets call for special retaining walls, double roadways, steps, terraces, along with the regular sewer systems. Attempts were made to treat each improvement at present existing on these streets so that a minimum damage will result thereto consistent with the best general scheme for the entire project. Some of these special improvements worked on are as follows:

Liberty Street between Noe and Church Streets.

Sanchez Street between Twentieth and Twenty-first Streets.

Collingwood Street between Twentieth and Twenty-second Streets.

Twenty-first Street between Castro and Diamond Streets.

Twenty-second Street between Castro and Diamond Streets.

Mendoza Avenue from Tenth Avenue westerly.

Coso Avenue between Prospect Avenue and Winfield Street, and the intersection of Coso and Prospect Avenues.

Quesada Avenue from Railroad Avenue to Newhall Street.

A contract was let for the last mentioned street on March 15, 1920, for the sum of \$23,000.75, involving the construction of retaining walls, steps, terraces, pavements, walks, and sewers. This work is practically complete.

Naval Base:

Realizing the importance of and the advantages that would accrue to the City of San Francisco by the establishment of a great naval base, that will cost approximately thirty-five million dollars, an extensive investigation has been made, data and drawings prepared and a comprehensive report issued setting forth the superior advantages of the Hunters Point district of San Francisco and establishing it as a logical place for the location of the United States Pacific Coast Naval Base.

Matters touching on the cost of development, proximity to labor supply, water supply, power supply, railroad facilities, proximity to anchorage grounds, together with its offering of solid rock foundations for the dry docks, were thoroughly dwelt on and placed in the hands of the commission charged with the duty of selecting the naval base site.

MUNICIPAL RAILWAYS.

During the fiscal year 1919-1920 very little new work was done in connection with the Municipal Railways of the City of San Francisco. Prior to the marked increase in the cost of materials and labor a substantial surplus had resulted from each year's operation. During the past year on account of increased operating costs there was no surplus with which to make additions and betterments to the system. The general financial conditions and the high price of money have made it undesirable to consider a bond issue to make the extensions which it would be desirable to construct now. Furthermore, with the possibility of the purchase of the United Railroads' lines within the next few years, no money should be expended except on a definite and comprehensive plan coordinating the lines of both systems. There will be submitted to the people at the election in November a charter amendment opening the way to the purchase of the corporation's system on the basis of partial payments out of earnings as explained under the heading "The McNab Plan" in my report for the fiscal year 1917-1918. The amendment will be similar to that presented in 1918 as Charter Amendment No. 27, which failed of passage by less than 3,000 votes out of a total of 71,000. If the proposed amendment carries it will be possible to determine definitely at what price and under what terms the property can be secured. This information can be used by the voter in determining at an election whether the city should or should not purchase the private company's holdings.

I have indicated above that the revenue from operation has not provided a surplus during the past two years. This, however, is not a serious state of affairs when the following things are considered. The street railway fare is still 5 cents with universal transfer privileges between Municipal Railway lines and transfers to a number of United Railroads lines and to one line of the California Street Cable Railway. Also the minimum wages of employees have been increased



Municipal Railway. Switching tower at Spear and Market Street.

from three dollars for eight hours to five dollars for eight hours, beginning July 1, 1919. The prices of all supplies have gone up very materially and power has twice been increased in price. Even with these increases in wages, material and power, it has not been necessary to discontinue the setting aside of 18 per cent of the gross receipts amounting to \$486,500.00 for depreciation and casualty reserves. In addition to this it has been possible to pay \$233,500.00 interest on outstanding bonds. The class of service given has been kept up to the high standard set at the commencement of municipal operation in 1912. These accomplishments are markedly better than those of most privately owned railway lines, with which it is the exception rather than the rule to maintain a 5 cent fare, and in view of the fact that the national street railway situation as affecting both urban and interurban lines became so acute as to necessitate the appointment of a federal commission by the President of the United States to study the question and, if possible, formulate some plan of relief, which it has not as yet done.

A careful observation of conditions obtaining in other cities of our country, both eastern and western, indicate that street railway conditions in San Francisco are far superior to that encountered elsewhere. It is only necessary to consider the marked increase in cost in ferry transportation and street railway fares in the east bay cities to appreciate the good fortune of San Francisco. Locally the cost of both gas and electricity has very markedly advanced. There has also been a slight advance in the cost of telephone service. But in San Francisco the street railway fare has remained stationary. This indicates the stability of municipally owned enterprises if properly constructed, operated and maintained. The local private corporation has not paid interest on its outstanding obligations for several years past and the maintenance of its tracks and equipment is not up to the standard set by the Municipal Railway.

During the year four contracts for work on the Municipal Railways were entered into. Of these new contracts one has been completed. Six contracts commenced in the preceding year were completed within the past twelve months. Descriptions of the work under each contract follow:

Contract No. 108, for furnishing and installing electric passenger elevator at Laguna Honda Station, Twin Peaks Tunnel. This contract was awarded to the Otis Elevator Company for \$15,350.00 on November 29, 1918. The work was completed and accepted on August 20, 1919. Final payment in the sum of \$15,570.00 was made to the Otis Elevator Company, \$220.00 being for extra work in connection with the doors.

Contract No. 111, for relocating the Union Street line from Franklin and Union Streets to Van Ness Avenue. This contract was awarded to the Healy-Tibbetts Construction Company on June 2, 1919, for \$21,274.00. This work was accepted September 12, 1919, and final payment in the sum of \$23,044.92 was made. This figure included extra work in connection with paving and a bonus.

Contract No. 113, for furnishing and delivering track special work was awarded on April 14, 1919. It was completed and finally accepted on August 20, 1919, payment in the sum of \$15,938.00, which was the contract price, being made at that time.

Contract No. 115, which was awarded on March 31, 1919, contemplated the delivery of 8,000 redwood cross-ties. Delivery was completed and the contract accepted on July 18, 1919. Final payment was made in the sum of \$7,803.50 as against \$7,320.00. This was due to excess shipments being made and as the ties were good and price below the market at the time of settlement it was decided to take all the ties which had been delivered.

Contract No. 119, which covered the installation of trolley wires and poles over the new location of the Union Street

line as contemplated in Contract No. 111, was awarded to Eccles & Smith on June 2, 1919. Final payment in the sum of \$1,404.47, and acceptance was made on October 22, 1919.

Contract No. 120 covers the installation of a short single track railway spur on Polk Street between Geary Street and Post Street connecting into the westbound track on Geary Street, which will be used as a place where a disabled car may be temporarily switched off the Geary Street line should a breakdown occur during rush hours. This work was awarded to C. B. Eaton on September 19, 1919, and was completed and accepted on October 22, 1919, at a cost of \$3,916.65.

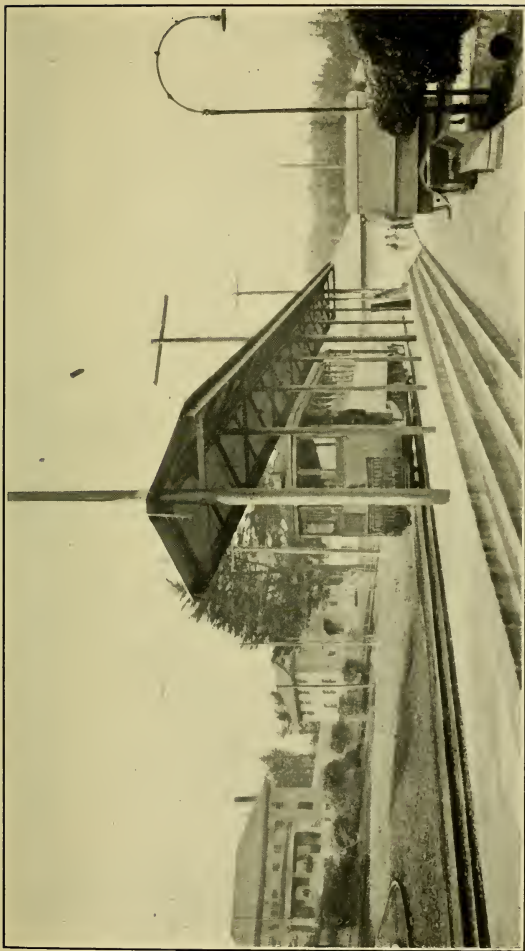
Contract No. 121, for a center entrance street car, was awarded to A. Meister & Sons Company of Sacramento on October 24, 1919. This contemplates the construction of a small lightweight, highgrade car of a type suitable for use on the Union Street line. Only one car is to be constructed under actual cost plus a percentage, the total estimated cost being \$12,500.00. The purpose in building one car only was in order to try out the car in actual service before placing orders for a considerable number of cars. The service on this line is peculiar in that grades up to almost 14 per cent are encountered, while the traffic is at times quite heavy. The car will be fitted with two 50 h.p. power motors driving 26-in. wheels in a single truck of the "Radiax" type, having a wheel base 12' 6" in length. The standard type "K" platform controller will be used in conjunction with an electro-pneumatic contactor installed under the car, making it unnecessary to break the trolley circuit in the platform controller; also providing a form of circuit breaker which will be entirely safe and efficient. It is expected that the car will be completed and placed in operation some time near the first of November. After a thorough tryout of the car, twenty similar cars embodying in them all of the improvements and changes suggested by the actual operation of the first will be purchased.

Contract No. 122 covered the furnishing and delivering of a track special work crossing for use at Ellis and Stockton Streets in connection with the rearrangement of the Market Street terminus of the Stockton Street line. This was awarded to the United States Steel Products Company on December 12, 1919, for \$2,239.00.

Contract No. 123. This contract for furnishing and mounting two automobile bus bodies was awarded to A. Meister & Sons Company of Sacramento on April 26, 1920. Two White 20-45 chassis were purchased and delivered to the Meister Company, which is building automobile bus bodies similar to those now in use by the city. The cost of these two bodies will be \$6,900.00.

Miscellaneous Work:

During the year several minor pieces of work worthy of consideration have been completed by the operating department under direction of this office. The first was the installation of a loop at the Presidio terminus of the Union Street tracks. The line ended in a stub track adjacent to an old frame building used by the post exchange officer as a canteen. The loop track was laid out and graded and a rearrangement of the rails and trolley wire completed and placed in operation on December 8, 1919. The commanding officer of the Presidio, through the post supply officer, requested that the city join the Government in the matter of rearranging the grounds and building a new exchange containing space for the railway. To this work the Superintendent of the Municipal Railway contributed from the operating funds the sum of \$1,000.00, and the Government spent almost \$1,000.00 in the erection of a small stucco finish building containing a news stand, bootblack stand, restaurant, toilet facilities and a room for the storage of tools and sand for the railway, also providing a place for a telephone. In addition to the loop construction a concrete landing platform with a galvanized iron umbrella shed was erected adjacent to the track to fur-



Municipal Railways. Presidio Terminal—Covered platform, waiting room and track loop in U. S. Military Reservation.

nish shelter for the railway patrons. The Presidio authorities have beautified the surroundings by a considerable amount of parking, making the Presidio terminal the best on our railway lines.

A second undertaking is that of providing better facilities on Stockton Street at Market Street for turning back cars operating on that line, at the same time making track rearrangement permitting of routing inbound Church Street and Twin Peaks Tunnel cars off Market Street via Van Ness Avenue and Geary Street to Stockton and Ellis Streets, thence via a new piece of track into the outbound Market Street track. Such facilities are necessary as it is impossible to provide a crossover between the two outside tracks on Market Street. Only at Van Ness Avenue, where by using the crossover in Van Ness Avenue and the branchoff out of Market Street, may a car be switched from one track to the other. This lack of crossovers greatly interferes with service when a blockade occurs on Market Street, at which time it is impossible to operate "J" and "K" cars east of Van Ness Avenue. This trouble is particularly noticeable at times of parades when the rear end of the parade has to reach Van Ness Avenue before a resumption of regular service can be commenced. With the new tracks in place cars may be operated via the loop formed by Van Ness Avenue, Geary, Stockton and Market Streets until the head of a parade reaches Stockton Street. A few cars held in Stockton Street during the passing of the parade will permit outbound cars to follow immediately behind the parade up Market Street. This work is now under way, the portion first undertaken being the rearrangement of the connection between the Geary Street and Stockton Street lines so as to turn southward out of Geary Street rather than northward.

It might be of interest to note the receipts and car hours operated by each line of the railway on June 30, 1920, as compared with the receipts of the corresponding day of the week (Wednesday) of the year previous:

Wednesday, July 2, 1919				Wednesday, June 30, 1920				
Line	Receipts 5c Fares	Car Hours	Re- ceipts per C. H.	Receipts 5c Fares	In- crease or De- crease	Car Hours	Re- ceipts per C. H.	In- crease or De- crease
"A".....	\$ 840.40	201	\$4.18	\$ 933.55	\$ 93.15	198	\$4.71	\$.53
"B".....	1,081.00	271	3.98	1,231.85	150.85	272	4.52	.54
"C".....	918.55	242	3.79	1,069.90	151.35	244	4.38	.59
"D".....	957.30	227	4.21	922.90	34.40	206	4.48	.27
"E".....	673.70	265	2.54	654.20	19.50	259	2.52	.02
"F".....	435.75	152	2.86	495.20	59.45	138	3.58	.72
"H".....	568.50	226	2.51	652.30	83.80	236	2.76	.25
"J".....	948.55	273	3.47	1,237.65	289.10	295	4.19	.72
"K".....	878.70	278	3.16	1,186.85	308.15	301	3.94	.78
"L".....	21.55	45	.47	29.75	8.20	43	.66	.19
All lines average increase.....								.48

Week Ending Wednesday, July 2, 1919,				Week Ending Wednesday, June 30, 1920,			
Total Revenue	Total C. H.	Revenue per C. H.	Total Revenue	Increase	Total C. H.	Revenue per C. H.	In- crease
\$51,404.13	15,155	\$3.38	\$55,018.95	\$3,614.82	15,111	\$3.64	\$.26

This indicates an increase in receipts per car hour of 48 cents. One line only showed a decrease in fares, namely, the "E" line, the reason for this being that during 1919 the very heavy traffic occasioned by the demobilization of the army increased the receipts considerably above the normal which could be expected. Also the operation of the "D" line direct to the Presidio has had a tendency to reduce the travel over the Union Street line. These figures should only be taken as indicating the general trend of operating revenue, due to the fact that many things influence the receipts, causing fluctuations from day to day. During the year the average increase of receipts per car hour has, however, been approximately 20 cents.

SURVEYS.

During the fiscal year a total of 646 orders for surveys were received. Of these 44 were for lot surveys and 602 were for surveys for public improvements and in answer to petitions or complaints. They include approximately as follows: 1,806 blocks and crossings, a total length of 753,102 lineal feet or 142.4 miles.

Precise levels were run covering about 58 miles; total number of bench marks rechecked and established, 2,464.

Approximate totals are as follows: 2,571 blocks and crossings, 1,059,342 lineal feet or 200 miles.

Fees collected and turned over to the City Treasurer, \$26,739.50.

Following is a detailed description of the work performed:

Made for	Number of Surveys	
Public contracts	110	
Private contracts	104	
Resurveys for contractors (lost points, etc.).....	101	
Municipal Department	287	602
<hr/>		
Lot surveys—		
Private owners	34	
Municipal departments	10	44
<hr/>		
Total.....		646

PRECISE LEVELS.

During the fiscal year ending June 30, 1920, precise levels were run and bench marks established, corrected or constructed, as follows:

100 Vara District.....	350
50 Vara District.....	412
Richmond District	422
Sunset District	96
Western Addition	312
Potrero and South San Francisco.....	190
University Mound	208
Mission and Horner's Addition.....	323
Other districts	151
<hr/>	
Total bench marks.....	2,464
Total miles of precise levels.....	58

NEW SUBDIVISIONS APPROVED AND FILED WITH THE RECORDER.

Title	Date Filed in Hall of Records
Harder & Daniels Mission Tract.....	October 8, 1919
Fifty Vara Block No. 216.....	October 28, 1919
Map of Fowler Avenue, Laguna Honda, and Dewey Boulevards	November 28, 1919
Map of Tara Street and Geneva Avenue.....	June 30, 1920

FEES RECEIVED FOR SURVEYS AND INSPECTION

1919	Surveys	Inspection Fees
July	\$ 633.00	\$ 2,236.60
August	570.75	584.40
September	296.00	703.50
October	807.00	1,821.50
November	740.50	2,369.00
December	666.00	1,184.00
1920		
January	743.75	1,909.50
February	193.50	1,131.75
March	1,042.75	1,723.75
April	458.00	2,032.00
May	742.50	1,596.75
June	763.50	1,789.50
Totals	\$7,657.25	\$19,082.25
		7,657.25
Grand total		\$26,740.50

HEICH HETCHY WATER SUPPLY.

Headquarters for the field administration of the Mountain Division of the project, covering all construction work from and including the Moccasin Creek power development to Lake Eleanor, are located at Groveland.

At this point are the division offices, the railroad shops, the main warehouse and the hospital. N. A. Eckart is in charge as constructing engineer.

Housing Conditions:

At headquarters the city has erected a club house with ten bed rooms, living room and dining room for the accommodation of single employees; twelve cottages with modern conveniences have been erected for the accommodation of employees with families.

Nine of these cottages were built during the past year to relieve the urgent demand for housing facilities.

These are all occupied, and with a waiting list in addition.

A rental is charged for rooms and cottages.

In the camps housing is provided for the employees in the shape of standard bunk houses, each house accommodating a maximum of six men. These bunk houses are neatly painted inside and out and kept clean, and may be considered models for construction camps. Washrooms and showers are provided in all camps.

Boarding Houses:

The city has owned and operated boarding houses in all camps, including the club house at headquarters, the same quality of food being furnished in all cases.

The men are charged \$1.25 per day for board, although, with the constantly rising price of foodstuffs, it has been impossible to operate the boarding houses at a cost of less than 50 cents per meal. This boarding house loss is charged out to the work and is in effect equivalent to a higher rate of wage. The value of good food, well prepared and

served, cannot be overestimated in attracting and holding a good class of labor, even as against higher wages in camps where the board and living conditions are not as favorable.

Hospital:

The Groveland Hospital, which was fully described in the last annual report, is perhaps as fully equipped and as complete as any hospital on a similar project.

The men are charged a fee of one dollar per month, which entitles them to free medical attention in case of sickness. The city carries compensation insurance with the State for all employees on the project, and all accident cases are treated at the hospital, for which service the accident insurance fund allows a rebate of 15 per cent of the premium paid.

In addition to the city employees, outside cases are occasionally cared for at established rates.

With the revenue obtained from the above sources the hospital is self-supporting.

All men coming to work, either for the city or the contractors, are required to pass a physical examination.

The number of cases treated during the past fiscal year was: Hospital cases, 196; non-hospital cases, 1,615.

Of the hospital cases, 158 were from the city operation, 11 from the Utah Construction work, and 27 were outside pay patients. Treatment of these cases included ten capital operations. The hospital cases average ten days each in the hospital.

Warehouses:

All material, equipment, provisions and supplies purchased for the Hetch Hetchy Construction, except the dam, are charged into the Groveland warehouse and from there charged to the work as issued.

Sufficient stock of consumable supplies is held to permit of taking advantage of quantity purchase and to avoid delay required for delivery from outside points.

The installation of this warehouse and system has been a large factor in promoting the efficiency of the work by eliminating delay in furnishing supplies and materials.

Groveland Shops:

The equipment of the railroad shops at Groveland has been augmented during the year by the installation of a Beaudry power hammer, a wheel press and a 36" Radial drill.

A new drop pit has been necessitated by the acquirement of two rod engines of 85 tons and 93 tons weight, respectively.

With the acquirement of a planer, the shop will be in position to handle all but the heaviest repair work.

In addition to the railroad work, the shop is in position to handle any emergency work for the tunnel and general construction work.

Groveland Water Supply:

During the past year a water supply for the city's use at Groveland has been installed.

The source of supply is a heavy water bearing seam encountered in sinking the Second Garrote shaft on the aqueduct line. This water is led into a pump chamber at the 270-foot level and from there pumped to the surface and through a 6-inch wooden stave line a distance of approximately 10,000 feet to two 30,000-gallon tanks on a hill above the city's property, thus affording a splendid fire protection. This was effective on June 15th in preventing the town of Groveland from being completely wiped out by fire. The town water supply was deficient, so a thousand feet of hose were run out from the city's supply and the fire was stopped at the Groveland Hotel.

Lake Eleanor Dam and Reservoir:

During the past year a crew of men worked in Lake Eleanor reservoir basin clearing out the standing timber in the flooded area. This crew averaged about fifteen men from

August (at which time the water level began to lower, due to draft from storage) until February when the rising level of the lake necessitated the laying off of the men.

A total of 100 acres were cleared during the season, leaving 400 acres yet to be cleared.

Lower Cherry Power Development:

A transmission line from Early Intake Power House to Damsite, together with substations at the damsite and at Mather, was completed and placed in operation in October, 1919, to supply power to the Utah Construction Company, for use in the construction of the Hetch Hetchy Dam, and to the city sawmill camp at Mather. In accordance with the terms of the contract, this power is being paid for by the contractor at the rate of 1 cent per k.w.h.

The length of this transmission line is 14.5 miles, which together with a transmission line from the power house in the opposite direction toward Priest makes a total of 33.7 miles.

During the past winter considerable difficulty was experienced with the power supply at Groveland, which was taken off the line of the Sierra and San Francisco Power Company beyond where it was joined by the city's lines. When the city was forced to separate from the Sierra Company on account of shortage of water, it was almost impossible to operate shop tools on the voltage delivered, and the lighting situation was equally bad.

For this reason a new transmission line 2.0 miles in length was constructed during December, 1919, from the Second Garrotte Shaft into Groveland, over the right of way secured for the water supply pipe between Groveland and Second Garrotte. This has settled the difficulties with power and light in Groveland.

From July 1, 1919, to June 30, 1920, the power house output amounted to 20,851,100 K.W.H., of which 13,227,000 were sold to the Pacific Gas and Electric Company, which on

January 1, 1920, took over the lines and the contract of the Sierra and San Francisco Power Company; 649,305 K.W.H. were sold to the Utah Construction Company for use at the dam, and 2,749,051 K.W.H. were used by the city in its own work. The difference between the sum of these and the output represents line and transformer losses and power unaccounted for on account of the inaccuracy of a multiplicity of meters being used to record against the output of one meter.

All of the power current used on the work is transformed to 440 volts from the 22,000 volts on the transmission wires. Lighting current is supplied at 110/220 volts.

The income from power sold to the Pacific Gas and Electric Company was \$66,135.00 for the year.

The season just past was possibly the driest that we are likely to encounter. Practically all of the snow in the mountains was melted by an exceptional rainfall in the last week of May, causing an early run-off in the mountain streams. Following this the stream flow fell off very rapidly, making it necessary to draw on storage for power beginning July 1st. Under normal conditions it would be unnecessary to use stored water for power purposes prior to the middle of August.

The voltage condition between the city's line and the Pacific Gas and Electric Company's line at Priest is being improved by the installation of a bank of "booster transformers," making a step in voltage of approximately 1,800 volts between the two lines. This will not only make it possible for the city to deliver power to the outside when operating but two machines at the power house, but will also give us a useful voltage back on to our line in case it is necessary to take our power house off of the line temporarily. It further facilitates quickly synchronizing the two systems.

Hetch Hetchy Dam:

On September 1, 1919, the Utah Construction Company, which was awarded the contract for constructing the Hetch

Hetchy Dam under Contract 61, assumed actual charge of the work on the ground, continuing in service such of the employees formerly working under the City Engineer's direction as desired to continue under the contractor.

From July 1st to September 1st the city's forces were engaged in the work of extending the diversion tunnel, 23x25 feet in section, and clearing and deepening the natural channel of the stream below the diversion tunnel outlet. This was to allow the river flow passed through the tunnel around the damsite a free discharge, so as to require only a comparatively low back water diversion dam above the tunnel outlet.

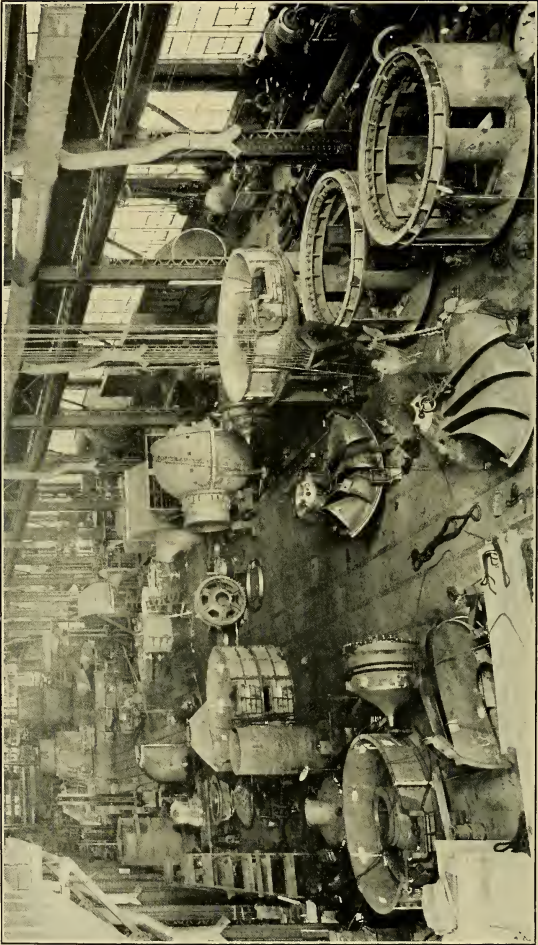
Provisions were made in the contract under which the contractors took over on a rental basis the camp buildings erected by the city, including warehouse, mess room, hospital and bunkhouses.

The following is a description of work accomplished by the Utah Construction Company from the date of their taking over the work until June 30th :

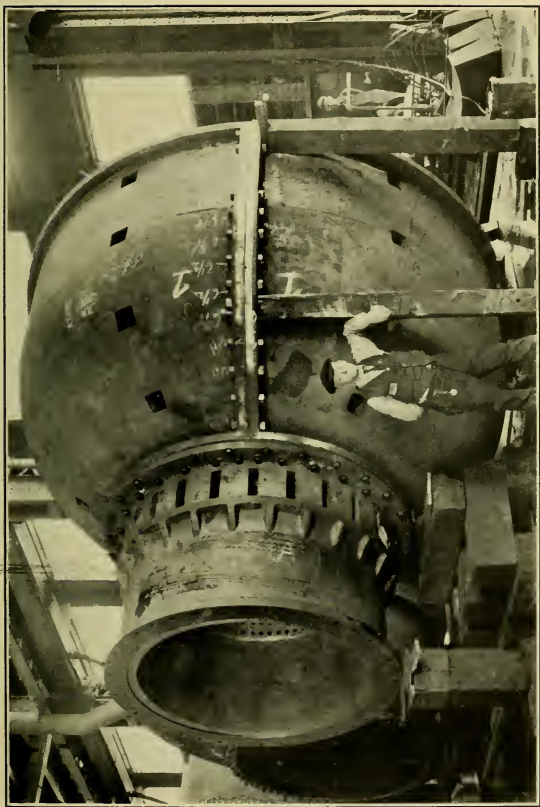
Camp Buildings:

Two camps have been installed, Camp No. 1 at Hodeau Flat, the campsite originally started by the city, and Camp No. 2 on the floor of the valley. At Camp No. 1, which includes the headquarters, there have been built by the contractor :

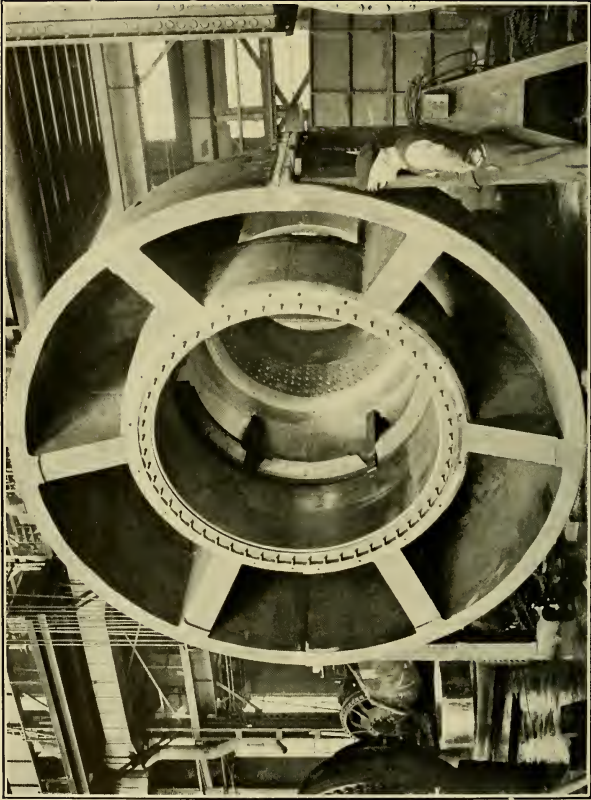
- 8 4-room cottages 22'x24'
- 6 2-room cottages 16'x21'
- 1 guest cottage 22'x24'
- 1 schoolhouse 16'x20'
- 1 store and office 24'x60'
- 7 bunkhouses 18'x36'
- 6 bunkhouses 16'x20'
- 1 amusement hall 24'x50'
- 1 compressor building, cor. iron, 40'x50'
- 1 machine shop, cor. iron, 26'x40'
- 1 blacksmith shop addition 14'x26'



Hetch Hetchy Dam—Outlet System.
60 inch by 36 inch valves in machine shop, I. P. Morris plant, Cramp Shipbuilding Co., Philadelphia, Pa.

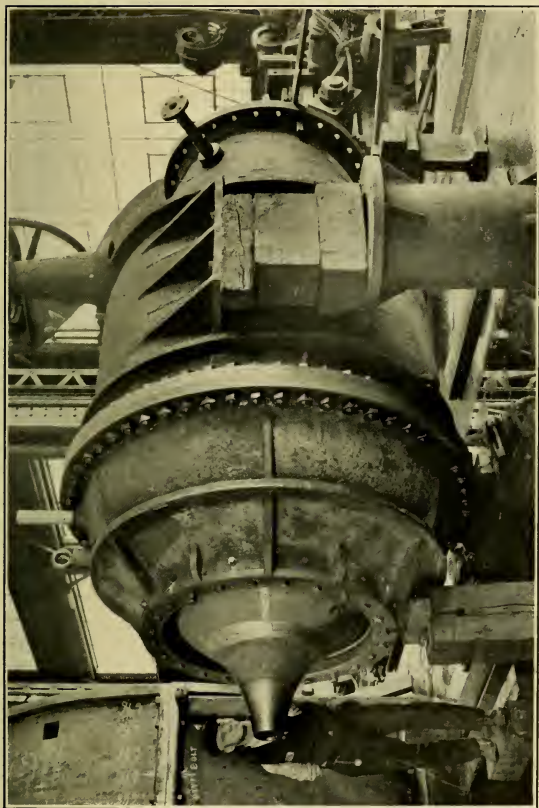


Hetch Hetchy Dam—Outlet System.
One of six 60-inch balanced valves. Body of valve with throat liner
and liner pipe—discharge end. Air ring removed.



Hetch Hetchy Dam—Outlet System.

One of six 60-inch balanced valves. Back head and plug removed, showing interior.



Hetch Hetchy Dam—Outlet System.

One of six 36-inch balanced valves, Larner-Johnson regulators, Showing plug in closed position.

At Camp No. 2 the following buildings have been erected:

- 1 cook house 24'x80'
- 7 bunkhouses 18'x36'
- 1 bunkhouse 16'x26'
- 3 bunkhouses 16'x20'
- 1 washhouse 24'x40'
- 1 meat house 10'x10'
- 1 4-room cottage 22'x24'

Tramway:

A combined standard and narrow gauge tramway, 700 feet in length, has been installed from the spur on the main line of the H. H. R. R. near the warehouse to the floor of the valley. This is equipped with a 15-ton electric hoist driven by 150 h.p. electric motor, in conjunction with which a derrick of 10 tons capacity has been installed at the upper end to transfer material from the cars to the tram car.

Cableway:

A messenger line has been installed across the damsite preparatory to stretching the main cable. The hoist has been installed with the exception of a 300 h.p. motor, delivery of which has been delayed. This cableway is a 15-ton Lidgerwood. The head tower is at elevation 3,928, 425 feet above the water surface. The tail tower is at elevation 3,815, span 903 feet.

Compressor Plant:

The compressor plant consists of:

1 Sullivan angle compound 20"x12"x14" compressor of 1200 cu. ft. capacity at 225 R.P.M., belt driven by a 200 H.P. Westinghouse motor; and,

1 Sullivan cross compound 20"x12½"x16" compressor of 920 cu. ft. capacity at 160 R.P.M., belt driven by 150 H.P. Westinghouse motor.

Cooling water is circulated by a 4"x6" Gould triplex pump, belt driven by a 5H.P. motor.

The plant is housed in a 40'x50' corrugated iron building.

Machine Shop:

The machine shop building is of corrugated iron, 26'x40', with a 14-foot addition for blacksmith shop.

The equipment at present installed is as follows:

- 1 24" American engine lathe
- 1 30" American radial drill
- 1 14" draw cut power saw
- 1 Victor oxy-acetylene welding outfit

Motive power for shop is furnished by a 15 H.P. Westinghouse motor.

Electric Power:

Electric power for the contract work is furnished from the City's Early Intake power house, a 1200 K.V.A. substation being installed at the damsite for delivering current to the contractor at 440 volts, for which a meter charge of 1 cent per K.W.H. is made.

Saw Mill:

A saw mill with a rated capacity of 40,000 ft. B.M. was installed by the Utah Construction Company on the floor of the valley and operated for several months, principally cutting material for the diversion dam.

Its operation was abandoned on completion of the crib diverting structure.

Valley Railroad:

A narrow gauge road was located, running from the dam along the north side of the valley a distance of some 7,000 feet to the rock quarry at the foot of Wampama Falls. This

railroad has been practically completed except a short stretch on the east end.

Crib Diversion Dam:

For diverting the flow of the Tuolumne from its channel through the diversion tunnel, a rock filled timber crib dam with plank facing has been constructed across the river channel. The dam in plan has an upstream angle and forms an easy entrance to the tunnel.

The crib work is of 12"x12" timbers pinned together with 1" drift pins. The lowest timbers are at elevation 3504, the elevation of the top timbers being 3537. The top width is 8 ft. with upstream batter of 3" per ft. and downstream steps of 4 ft. in 6 ft. rise. The spacing of the up and down stream timbers is 8 ft., these pockets being filled with large loose rock dumped in from cars and partially hand placed.

The upstream face is sheathed with a double layer of 2" plank between which is a layer of burlap. The sheathing is carried to elevation 3540 as the crest of the dam.

Prior to the placing of the cribwork, a row of Wakefield sheet piling was driven across the stream bed to a layer of hard pan overlying some softer, fine material. The sheet piling was cut to elevation 3507.5, the space between the sheathing and sheet piling being filled with an asphaltic mixture.

The length of the crib dam along the crest is 321 ft.

In May the dam successfully withstood the maximum flood water of the year, which reached elevation 3528 on the dam face.

Backwater Diversion Dam:

Just upstream from the outlet of the diversion tunnel a concrete backwater dam has been constructed.

This dam is 51.5 ft. long on the crest at elevation 3520 and 28 ft. on the foundation at elevation 3478.

The lower section of the dam is 33 ft. wide to elevation 3495, stepping in at that point to a width of 21 ft., then with

uniform batter equal up and down stream, reducing to 3 ft. width at the crest.

Two 24-in. pipes are laid through the dam at elevation 3497. These are fitted with check valves.

Twenty-seven 2-in. pipes were built into the dam for the purpose of grouting the foundation, which is on boulders and coarse gravel. One hundred and seventy-three sacks of cement were forced into the foundation.

The concrete yardage is 564 in the foundation block and 421 in the upper section.

Diversion Tunnel:

As part of the contract, the diversion tunnel was extended down stream approximately 600 ft. and the section of the original diversion tunnel increased from 20x20 ft. to 23x25 ft. The extension of the diversion tunnel was prosecuted in both directions from a short inclined shaft or winze.

The heading at the lower end broke through at 11 p. m., October 18, and the upper end, 3 p. m., October 23, 1919.

The tunnel excavation was completed and the river diverted through on January 16, 1920.

The concrete plug in the outlet of the old diversion tunnel was completed January 13, 1920. This contains 382 cu. yds.

Excavation for Foundations:

Excavation for the dam foundation was not actually commenced until December. A trail was constructed on the north side and the stripping and keyway excavation started from the top, two shifts being used.

The excavated material was worked down to a Marion 36 caterpillar shovel with 1¼-yd. dipper, which loaded it into 4-yd. cars operated by 18-ton Porter Saddle Tank narrow gauge locomotives. The spoil is being used for making fills for the Valley R. R., and part was used in filling the diversion crib dam.



Hetch Hetchy Water Supply. Excavating main dam foundation.

The number of men employed on this work has been comparatively small owing to hazard from falling rocks in excavating the side bluffs. The steam shovel was out of service May 16th to 24th on account of high water, which could not be handled on account of the pumping capacity being limited, due to delay in delivery of electrical equipment for the pumps.

The total yardage excavated in the dam foundation to June 30th was 50,000 cu. yds.

City Sawmill:

The month of June, 1919, completed the sawing of the available timber at the site of the Canyon Ranch Mill.

It was decided then to move the mill to Mather, formerly Hog Ranch. Work was commenced immediately on the construction of the necessary track connections from the main line at Mather to the site of the mill.

The available timber on the city's holdings at Mather amounted to 3,637 M ft. In addition to this there was acquired by purchase 4,603 M ft., making a total stand in the city's possession of 8,240 M ft. In addition to this there is available 1,500 M ft. stumpage which can no doubt be acquired from the Government, and which is located as close to the mill as some of our own holdings.

The mill is conveniently laid out, a mill pond being provided, by excavation, from which the logs are handled to the log deck by friction driven log haul.

More power has been provided so that the mill capacity has been somewhat increased.

Sawing operations were commenced at Mather on October 20, 1919, and from that date to January 23rd, when the mill was closed for the season, 1,196,389 ft. of lumber were cut. On May 15th the mill opened again, cutting from that date to June 30th 402,287 ft., a total for the fiscal year of 1,598,676 ft. B.M.

Aqueduct Tunnel:

In 1917 bids were invited by the city for constructing the 18-mile aqueduct tunnel from the Early intake to Priest forebay reservoir. The bids were excessively high and were therefore rejected.

The city then proceeded to do the work by day labor, and succeeded in establishing a record for economy in tunnel construction, although, owing to limited funds available, work was prosecuted only from three headings until February, 1920, and thereafter from five headings, whereas had sufficient money been available the work could have been carried on from fourteen or more headings and the progress thereof increased in similar proportion. After demonstrating the price for which the work could be performed, the remainder of the tunnel was again put up to contract.

To eliminate, if possible, certain objectionable features of the flat price contract, it was decided to advertise for bids on a cost-plus-fee basis as well.

The disadvantages of the flat price contract were that the abnormal and uncertain condition of the labor and material market would influence a contractor to provide a large margin of safety in his bid for upward fluctuations, thereby increasing the cost; second, extremely large performance and lien bonds are required by law on a flat price contract (in this instance the bond would be for approximately \$4,000,000 and would exceed the bonding capacity of all the bonding companies in California); third, under the flat price arrangement 25 per cent of all progress payments are withheld until the completion of the work, greatly increasing the interest during construction; fourth, a very heavy outlay would be required of the contractor at the start of the work for plant and equipment, and the interest thereon the contractor would necessarily charge against the work.

Cost-plus-percentage contracts have been found by the Government and private corporations to be excessively expensive, there being no financial incentive for the contractor

to reduce his costs to a minimum, but on the contrary he receives a greater remuneration the greater the cost of the contract. On the cost-plus-fee basis, however, which was adopted by the city, the contractor was required to guarantee that unit costs on the various classes of the work would not exceed a maximum price, to be named by the contractor in his bid. This protects the city against unduly costly work; moreover, the contractor's fee is a definite quantity and not a percentage of the cost of the work.

An ordinance was adopted by the Board of Supervisors providing that, should the work be let on the cost-plus-fee basis, all pay rolls and material bills would be approved by the City Engineer and Board of Public Works and be paid directly by the city. The contractor would organize and superintend the construction, submit to the city prices on construction equipment and, if the same were lower than the city could secure, furnish the same, to be paid for by the city.

Alternative cost-plus-fee bids were invited: one type providing for spreading the contractor's fee evenly over the entire period required for construction; the other permitting the bidder to name a part of his fee as an advance payment, payable at the beginning of each year that the contract was in force to cover the estimated actual expense incurred by the contractor prior to the commencement of the work.

The following is a tabulation of the bids received on all propositions:

It will be noted that the lowest price for constructing the tunnels under the flat price bid, Proposition "A" (tunnels lined with concrete throughout) was \$9,901,720, whereas under the cost-plus-fee basis, with maximum unit cost guaranteed, the price was \$7,802,952. As the work on the cost-plus-fee basis is to be performed by the contracting company under the absolute jurisdiction of the City Engineer, and as it has been demonstrated beyond a doubt for what price this work can be performed, the Board of Public Works and Supervisors, after consultation with the Acting Mayor, City Attorney, and counsel for the various companies that submitted bids, awarded a contract to the Construction Company of North America on the cost-plus-fee basis.

The validity of this type of contract was immediately attacked in the courts by "tax payers"—merely another obstacle thrown in the way of the completion of the Hetch Hetchy project by interests inimical to San Francisco. The suit is being defended by the Special Counsel for the Hetch Hetchy, Attorney Robert M. Searls, under the general direction of City Attorney George Lull. Both declare strongly for the validity of the contract.

The city's construction forces were turned over to the contractor on May 17, 1920, on which date the Construction Company of North America assumed direction of the work under Contract No. 77-C.

Priest Portal:

A progress of 2915 ft. was made in this heading, in a formation of slate, quartzite and mica schist that at times required timbering. A Myers-Whaley shoveling machine was in continuous service and unquestionably accounts for the maximum progress with the minimum cost for the work. The average cost per lineal foot, exclusive of overhead and plant charge, was \$18.18 for labor and \$9.28 for material.

Hetch Hetchy Water Supply. Armstrong "Shoveloder" in Big Creek Tunnel Heading.

NETCH NETCHY WATER SUPPLY OF THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA

UNIT PRICE BASIS

RECORD OF BIDS RECEIVED

APR 21 1920

Item No.		ITEM	Quantity Estimated	Unit	No. 1 Bidders Name and Address E.C. STUBBS & CO. 808 CONCRETE BLDG. SAN FRANCISCO Total bid on entire contract A- 9,907,210 - B- 3,674,208 -	No. 2 Bidders Name and Address UNITED CONTRACTORS 121-121 E. AVE. SAN FRANCISCO Total bid on entire contract A- 10,311,051.20 B- 16,250,263 -	No. 3 Bidders Name and Address UNITED CONTRACTORS 121-121 E. AVE. SAN FRANCISCO Total bid on entire contract A- 10,311,051.20 B- 16,250,263 -	No. 4 Bidders Name and Address UNITED CONTRACTORS 121-121 E. AVE. SAN FRANCISCO Total bid on entire contract A- 10,311,051.20 B- 16,250,263 -	No. 5 Bidders Name and Address UNITED CONTRACTORS 121-121 E. AVE. SAN FRANCISCO Total bid on entire contract A- 10,311,051.20 B- 16,250,263 -	Total
PROPOSITION "A"										
All tunnels fully lined through- out with concrete.										
1		Lined tunnel between South Fork and Adit No. 8 - 9.	16 400	lin. ft.	107 - 1754,800 -					178 50 297,400 -
2		Lined tunnel between South Fork and Adit No. 8 - 9.	24 744	lin. ft.	105 - 2554,120 -					107 30 3247,600 -
3		Extra price for permanently lin- ed and Priest Portal.	41 600	lin. ft.	109 - 4524,400 -					173 - 2,958,000 -
4		Extra price for permanently lin- ed and Priest Portal.	10 000	lin. ft.	10 - 100,000 -					25 60 256,000 -
5		Concrete lining in tunnels excavat- ed by the City.	24 000	cu. yds.	20 - 480,000 -					28 15 637,600 -
6		Concrete lining in shafts excavated by the City.	2 700	cu. yds.	22 - 59,400 -					30 - 81,000 -
7		Additional excavation in tunnel and shafts.	428	lin. ft.	440 - 170,000 -					54 - 228,500 -
8		Additional concrete in tunnel and shaft.	8 000	cu. yds.	10 - 50,000 -					34 - 170,000 -
9		Extending adits.	2 000	cu. yds.	20 - 100,000 -					28 15 130,780 -
10		Excavation in o. m. cul.	160	lin. ft.	40 - 4,000 -					27 - 2,700 -
11		Concrete in o. m. cul.	500	cu. yds.	8 - 4,000 -					2 - 1,000 -
12		Concrete in o. m. cul.	500	cu. yds.	20 - 10,000 -					15 - 7,500 -
13		Extra cement.	5 000	bbls.	6 00 30,500 -					6 25 41,250 -
14		Pump and jack, rolled steel.	40	000 lbs.	10 - 4,000 -					12 - 4,800 -
15		Reinforcing steel furnished by the City.	10 000	lbs.	10 - 500 -					62 200 -
TOTALS, PROPOSITION "A"					980,720 -					1631,981 20
PROPOSITION "B"										
All tunnels fully lined through- out with concrete.										
1		Lined tunnel between South Fork and Adit No. 8 - 9.	200	lin. ft.	117 50 23,500 -					178 50 35,700 -
2		Lined tunnel between South Fork and Adit No. 8 - 9.	12 000	lin. ft.	105 80 127,000 -					107 30 3247,600 -
3		Extra price for permanently lin- ed and Priest Portal.	41 600	lin. ft.	110 - 452,000 -					173 - 2,958,000 -
4		Extra price for permanently lin- ed and Priest Portal.	10 000	lin. ft.	10 - 100,000 -					27 - 270,000 -
5		Concrete lining in tunnels excavat- ed by the City.	15 800	cu. yds.	22 - 346,400 -					25 25 243,250 -
6		Concrete lining in shafts excavated by the City.	2 700	cu. yds.	22 - 59,400 -					20 15 70,625 -
7		Additional excavation in tunnel and shafts.	428	lin. ft.	440 - 170,000 -					54 - 228,500 -
8		Additional concrete in tunnel and shaft.	8 000	cu. yds.	10 - 50,000 -					34 - 170,000 -
9		Extending adits.	2 000	cu. yds.	20 - 100,000 -					28 15 130,780 -
10		Excavation in o. m. cul.	160	lin. ft.	40 - 4,000 -					27 - 2,700 -
11		Concrete in o. m. cul.	500	cu. yds.	8 - 4,000 -					2 - 1,000 -
12		Concrete in o. m. cul.	500	cu. yds.	20 - 10,000 -					15 - 7,500 -
13		Extra cement.	5 000	bbls.	6 00 30,500 -					6 25 41,250 -
14		Pump and jack, rolled steel.	40	000 lbs.	10 - 4,000 -					12 - 4,800 -
15		Reinforcing steel furnished by the City.	10 000	lbs.	10 - 500 -					62 200 -
16		Unlined tunnel with pored linest. between South Fork and Adit No. 8-9.	16 200	lin. ft.	97 50 157,500 -					165 - 277,800 -
17		Unlined tunnel with pored linest. between South Fork and Adit No. 8-9.	12 744	lin. ft.	94 50 120,300 -					162 - 269,400 -
18		Completing tunnels excavated by the City.	7 000	lin. ft.	27 50 192,500 -					67 20 468,400 -
TOTALS, PROPOSITION "B"					3,574,208 -					16250,263 -
SUMMARY OF BIDS UNDER ALL PROPOSITIONS										
UNIT PRICE BASIS, CONTRACT NO. 77										
PROPOSITION "A"										
"A"					9,907,210 -					16,311,051 20
"B"					3,574,208 -					16,250,263 -
"C"					2,722,750 -					3,201,545 -
"D"					1,828,450 -					2,003,160 -
"E"					7,922,570 -					1,995,660 -
"F"					7,051,798 -					3,283,283 -
COST-PLUS-FEE BASIS, CONTRACT 77-C										
TOTAL AMOUNT OF FEE										
GUARANTEED MAXIMUM COST, PROPOSITION "A"										
"A"					1,674,285 80					3,890,100 -
"B"					8,452,940 -					7,802,932 40
"C"					8,799,166 -					16,246,689 -
"D"										7,291,902 -

SUMMARY OF BIDS UNDER ALL PROPOSITIONS

UNIT PRICE BASIS CONTRACT NO. 77

[illegible]

COST-PLUS-FEE BASIS CONTRACT 77-C

																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					</
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	----

Hetch Hetchy Water Supply. Armstrong "Shoveloder" in Big Creek Tunnel Heading.

HETCH HETCHY WATER SUPPLY OF THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA.

CONSTRUCTION OF THE AQUEDUCT TUNNEL BETWEEN EARLY INTAKE & SOUTH FORK UNIT PRICE BASIS

CONTRACT NO. 77-A

RECORD OF BIDS RECEIVED

APR 21, 1920

Item No.	ITEM	Quantity Estimated	Unit	No. 1 Bids Name and Address A.C. STORCK & CO., 804 CROCKER BLDG., SAN FRANCISCO C: 2,073,750. D: 1,074,450.	No. 2 Bids Name and Address UTAH CONSTRUCTION CO., 102 PHILAN. BLDG., SAN FRANCISCO Total bid on entire contract C: 2,683,000. D: 1,585,600.	No. 3 Bids Name and Address HEALY, TIBBETTS & ASSOCIATES, 3 MAIN ST., SAN FRANCISCO Total bid on entire contract C: 3,351,545. D: 3,283,715.	No. 4 Bids Name and Address CONSTRUCTION CO. OF CALIFORNIA, 711 - 713 AVI., SAN FRANCISCO Total bid on entire contract	No. Bids Name and Address
	PROPOSITION "A"							
1	Tunnel to be fully lined throughout	16 400	lin.ft.	107 - 1,254,000 -	150 - 2,464,000 -	178 50 2,472,400 -		
2	Lined tunnel between Early Intake and South Fork	200	lin.ft.	10 - 2,020 -	10 - 2,000 -	25 60 5,170 -		
3	Extra price for permanently timbered tunnel	11 800	cu.yds.	22 - 253,000 -	35 - 407,500 -	26 15 300,725 -		
4	Concrete lining in tunnel excavated by the City.	200	cu.yds.	10 - 2,000 -	10 - 3,600 -	34 - 6,800 -		
5	Additional excavation in tunnel.	200	cu.yds.	20 - 4,000 -	31 - 6,260 -	26 15 5,230 -		
6	Additional concrete in tunnel.	200	cu.yds.	8 - 1,600 -	5 - 1,000 -	1 - 400 -		
7	Excavation in open cut.	200	cu.yds.	20 - 4,000 -	23 - 4,600 -	15 - 3,000 -		
8	Concrete in open cut.	200	bb's.	8 50 1,300 -	4 - 1,800 -	8 25 1,650 -		
9	Extra cement	10 250	lbs.	10 1,000 -	13 1,300 -	12 1,200 -		
10	Placing and placing reinf.steel.	1 500	lbs.	05 50 -	08 80 -	02 20 -		
11	Placing reinforcing steel furnished by the City.							
	TOTAL, PROPOSITION "A"			2,073,750 -	2,683,000 -	3,283,715 -		
	PROPOSITION "B"							
1	Lined Tunnel between Early Intake and South Fork	200	lin.ft.	117 50 2,500 -	150 - 30,000 -	223 10 44,670 -		
2	Extra price for permanently timbered tunnel	200	lin.ft.	10 - 2,000 -	10 - 2,000 -	33 75 6,750 -		
3	Concrete lining in tunnel excavated by the City.	800	cu.yds.	30 - 15,000 -	35 - 17,500 -	32 75 16,375 -		
4	Additional excavation in tunnel	200	cu.yds.	10 - 2,000 -	18 - 3,600 -	42 50 5,500 -		
5	Additional concrete in tunnel	200	cu.yds.	20 - 4,000 -	31 - 6,260 -	32 75 6,550 -		
6	Excavation in open cut.	200	cu.yds.	8 - 1,600 -	5 - 1,000 -	2 - 400 -		
7	Concrete in open cut.	200	bb's.	20 - 4,000 -	23 - 4,600 -	15 - 3,000 -		
8	Extra cement	800	bb's.	6 50 1,300 -	9 - 1,800 -	8 25 1,650 -		
9	Placing and placing reinf.steel.	10 200	lbs.	10 1,000 -	13 1,300 -	12 1,200 -		
10	Placing reinforcing steel furnished by the City.	1 800	lbs.	05 50 -	08 80 -	02 20 -		
11	Lined tunnel with pored invert, between Early Intake and South Fork	16 200	lin.ft.	97 50 1,574,500 -	108 - 1,749,600 -	169 - 2,737,800 -		
12	Concrete lining in tunnel excavated by the City.	7 000	lin.ft.	27 50 1,92,500 -	24 - 168,000 -	65 20 454,400 -		
	TOTAL, PROPOSITION "B"			1,874,450 -	1,985,600 -	3,023,715 -		

NO BID ON THIS PROPOSITION

NO BID ON THIS PROPOSITION

NO BID ON THIS PROPOSITION

HETCH HETCHY WATER SUPPLY OF THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA

CONTRACT NO. 77-B CONSTRUCTION OF AQUEDUCT TUNNELS BETWEEN SOUTH FORK & PRIEST

UNIT PRICE BASIS

APR. 21, 1920

RECORD OF BIDS RECEIVED

Item No.	ITEM	Quantity Estimated	Unit	Bidder's Name and Address	Unit Price bid per unit of work	Total bid amount	Bidder's Name and Address	Unit Price bid per unit of work	Total bid amount	Bidder's Name and Address	Unit Price bid per unit of work	Total bid amount
1	PROPOSITION #1											
2	All tunnels to be fully lined with concrete.											
3	Lined tunnel between South Fork & Adit No. 8-9.	24,744	lin. ft.	105	-	2,598,120	-					
4	Lined tunnel between Adit 8-9 & Adit No. 8-9.	41,700	lin. ft.	105	-	4,378,500	-					
5	Extra price for permanently timbered tunnel.	9,200	lin. ft.	10	-	92,000	-					
6	Concrete lining in tunnels excavated by the City.	12,500	cu. yds.	22	-	275,000	-					
7	Concrete lining in shafts excavated by the City.	2,700	cu. yds.	22	-	59,400	-					
8	Constructing shaft No. 2, with lining below top part excavated by the City.	425	lin. ft.	400	-	170,000	-					
9	Additional excavation in tunnel and shaft.	4,300	cu. yds.	10	-	43,000	-					
10	Additional concrete in tunnel and shaft.	4,300	cu. yds.	20	-	86,000	-					
11	Extending adits.	100	lin. ft.	40	-	4,000	-					
12	Excavation in open cut.	120	cu. yds.	8	-	960	-					
13	Concrete in open cut.	100	cu. yds.	20	-	2,000	-					
14	Extra cement.	4,800	bb's.	6.50	-	31,200	-					
15	Furnishing and placing reinforced, placing reinforcing steel furnished by the City.	30,000	lbs.	10	-	3,000	-					
16	Placing reinforcing steel furnished by the City.	2,000	lbs.	05	-	100	-					
17	TOTAL, PROPOSITION #1					7,125,920	-					
18	PROPOSITION #2											
19	All tunnels to be fully lined with concrete.											
20	Lined tunnel between South Fork and Adit No. 8-9.	13,200	lin. ft.	106.50	-	1,404,900	-					
21	Extra price for permanently timbered tunnel.	41,500	lin. ft.	10	-	415,000	-					
22	Concrete lining in tunnels excavated by the City.	9,800	lin. ft.	10	-	98,000	-					
23	Concrete lining in shafts excavated by the City.	12,500	cu. yds.	22	-	275,000	-					
24	Constructing shaft No. 2, with lining below top part excavated by the City.	2,700	cu. yds.	22	-	59,400	-					
25	Additional excavation in tunnel and shaft.	425	lin. ft.	400	-	170,000	-					
26	Additional concrete in tunnel and shaft.	4,300	cu. yds.	10	-	43,000	-					
27	Extending adits.	4,800	cu. yds.	20	-	96,000	-					
28	Excavation in open cut.	100	lin. ft.	40	-	4,000	-					
29	Concrete in open cut.	100	cu. yds.	8	-	800	-					
30	Extra cement.	300	cu. yds.	20	-	6,000	-					
31	Furnishing and placing reinforced, placing reinforcing steel furnished by the City.	4,800	bb's.	6.50	-	31,200	-					
32	Placing reinforcing steel furnished by the City.	30,000	lbs.	10	-	3,000	-					
33	Unlined tunnel with paved invert, between South Fork and Adit No. 8-9.	9,000	lin. ft.	05	-	450	-					
34	TOTAL, PROPOSITION #2					7,851,750	-					

Hetch Hetchy Water Supply. Armstrong "Shoveloder" in Big Creek Tunnel Heading.

HETCH HETCHY WATER SUPPLY OF THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA

CONTRACT NO. 77-C

CONSTRUCTION OF AQUEDUCT TUNNELS IN THE MOUNTAIN DIVISION

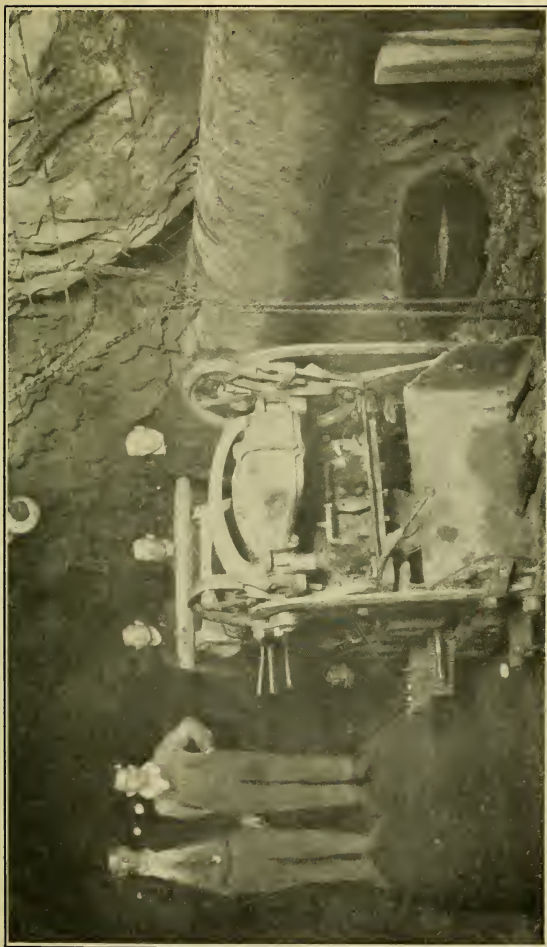
APR. 21, 1920.

COST-PLUS-FEE BASIS

RECORD OF BIDS RECEIVED

PROPOSALS X AND Y

Item No.	ITEM	Quantity Estimated	Unit	No. 1..... Bidders Name and Address R. C. STORRIE & CO., 804 CROCKER BLDG., SAN FRANCISCO. Total bid on entire contract \$ 1,074,288.40	No. 2..... Bidders Name and Address UTAH CONSTR. CO., 5 MAIN ST., SAN FRANCISCO. Total bid on entire contract \$ 3,400,000.00	No. 3..... Bidders Name and Address HEALY, THIBOUTS, 5 MAIN ST., SAN FRANCISCO. Total bid on entire contract \$ 1,390,379.30	No. 4..... Bidders Name and Address CONSTR. CO. OF SAN FRANCISCO. Total bid on entire contract \$ 1,390,379.30	No. Bidders Name and Address	
	Total amount of fee.			PROPOSAL X 1074288.40	PROPOSAL Y 3400000.00	PROPOSAL X 1390379.30	PROPOSAL Y 1390379.30		
	Amount of each annual advance payment.			267 671.40			276 776.40		
	GUARANTEED MAXIMUM UNIT COSTS								
	PROPOSITION "A"								
	All tunnels fully lined throughout.								
1	Lined tunnel between Early Intake and South Fork.	16 400	lin.ft.	96	1574 400	178 50	1321 400	78 95 1284 780	
2	Lined tunnel between South Fork and Adit No. 9-9.	24 744	lin.ft.	25	2350 460	187	1467 125	84 20 707 083 444.60	
3	Lined tunnel between Adit No. 9-9 and Private Portal.	41 500	lin.ft.	38	4076 000	173	7196 500	82 08 3416 518	
4	Extra price for permanently timbered tunnels, lining in tunnels excavated previous to this contract.	10 000	lin.ft.	9	90 000	25 40	254 000	25	250 000
5	Concrete lining in shafts excavated previous to this contract.	24 000	cu.yds.	18	432 000	26 15	617 600	16 50	396 000
6	Concrete lining in shafts excavated previous to this contract.	2 700	cu.yds.	20	54 000	30	81 000	20	54 000
7	Constructing Shaft No. 2, with lining in tunnel and shaft excavated previous to this contract.	428	lin.ft.	400	170 000	540	225 500	330	140 250
8	Additional excavation in tunnel and shaft.	5 000	cu.yds.	10	50 000	34	170 000	10 50	52 500
9	Additional concrete in tunnel and shaft.	5 000	cu.yds.	20	100 000	26 15	130 750	15	75 000
10	Excavation adits.	100	lin.ft.	35	3 500	27	2 700	45	4 500
11	Excavation in open cut.	500	cu.yds.	8	4 000	2	1 000	2 50	1 250
12	Concrete in open cut.	500	cu.yds.	20	10 000	15	7 500	15	7 500
13	Extra cement.	5 000	lbs.	6 50	32 500	6 25	41 250	5	25 000
14	Furnishing and planing rebar.	40 000	lbs.	10	4 000	12	4 800	10	4 000
15	Placing reinforcing steel furnished by contractor.	10 000	lbs.	05	500	02	200	02	200
	TOTALS, PROPOSITION "A"			8352 360		16203 628			7807 952.80
	GUARANTEED MAXIMUM UNIT COSTS								
	PROPOSITION "B"								
	Excavation in open cut, from Early Intake to the fully lined shaft.								
1	Lined tunnel between Early Intake and South Fork.	200	lin.ft.	100	70 000	178 50	35 700	82 94	16 586
2	Lined tunnel between South Fork and Adit No. 9-9.	12 000	lin.ft.	94	1152 000	187	2724 000	84 17	1010 040
3	Lined tunnel between Adit No. 9-9 and Private Portal.	41 600	lin.ft.	37	4032 000	173	7096 800	81 58	3393 716
4	Extra price for permanently timbered tunnel.	10 000	lin.ft.	9	90 000	27	270 000	21	210 000
5	Concrete lining in tunnels excavated previous to this contract.	13 000	cu.yds.	20	260 000	25 25	328 250	16 50	214 500
6	Concrete lining in shafts excavated previous to this contract.	2 700	cu.yds.	20	54 000	26 15	70 605	20	54 000
7	Constructing Shaft No. 2, with lining in tunnel and shaft excavated previous to this contract.	428	lin.ft.	400	170 000	540	225 500	330	140 250
8	Additional excavation in tunnel and shaft.	5 000	cu.yds.	10	50 000	34	170 000	10 50	52 500
9	Additional concrete in tunnel and shaft.	5 000	cu.yds.	20	100 000	26 15	130 750	14	70 000
10	Excavation adits.	100	lin.ft.	35	3 500	27	2 700	45	4 500
11	Excavation in open cut.	500	cu.yds.	8	4 000	2	1 000	2 50	1 250
12	Concrete in open cut.	500	cu.yds.	20	10 000	15	7 500	15	7 500
13	Extra cement.	5 000	lbs.	6 50	32 500	6 25	41 250	5	25 000
14	Furnishing and placing rebar.	40 000	lbs.	10	4 000	12	4 800	10	4 000
15	Placing reinforcing steel furnished by contractor.	10 000	lbs.	05	500	02	200	02	200
16	Excavation in open cut, from Early Intake to the fully lined shaft.	10 800	lin.ft.	92	9096 000	149	273 600	66 87	1083 204
17	Excavation in open cut, from Adit No. 9-9 to the fully lined shaft.	12 744	lin.ft.	90	1146 960	182	239 408	67 86	64 528.94
18	Excavation in open cut, from Adit No. 9-9 to the fully lined shaft.	7 000	lin.ft.	25	175 000	65 20	456 400	20	140 000
	TOTALS, PROPOSITION "B"			8798 060		16246 663			7327 907.94



Hetch Hetchy Water Supply. Armstrong "Shoveloder" in Big Creek Tunnel Heading.

Big Creek:

A rock pocket with the necessary equipment for loading the skips below the tunnel grade and a compartment at the tunnel grade for storage of equipment and for repairs were completed and drifting started east and west from the shaft. The east heading was advanced 706 ft. and the west heading 1087 ft. in a formation of siliceous schist with quartzite.

An Armstrong "shoveloder," made by the Lake Superior Loader Company, was installed and has been in service since February 15th. Average cost per lineal foot for labor \$28.66 and \$11.33 for material.

South Fork:

With hand mucking a progress of 1959 ft. was made in a formation of granite. Tunnel Section No. 2, with vertical walls, was changed on January 3d to Section No. 1 with curved walls, and changed again on May 1st to Section No. 3. With the exception of the invert, Section No. 3 is unlined, but the sectional area is 46 per cent greater than that of Section No. 2.

The average cost per lineal foot for labor was \$24.15 and for material \$9.45.

Early Intake:

A progress of 1942 ft. was made in a granite formation.

A Myers-Whaley shoveling machine was installed and has been in service since January 20th. The efficiency of the mucking machine may be shown by the following comparison:

In December, 1919, with hand mucking a progress of 188 ft. was made at a cost of \$26.19 per lineal foot for labor and \$10.79 for material. In February, 1920, with the mucker in service a progress of 250 ft. was made at a cost of \$20.17 for labor and \$11.43 for material.

On May 1st a large volume of water under a pressure of 240 lbs. per sq. in. was encountered, which flooded the tun-

nel and caused a suspension in the work until pumping equipment could be installed to handle the flow.

The average cost per lineal foot in this heading was \$24.89 for labor and \$11.22 for material.

Second Garrotte:

Second Garrotte shaft was sunk to a depth of 319 ft., a progress of 42 ft. being made. Large quantities of water were encountered, which stopped excavation and flooded the shaft from November 11, 1919, to April 20, 1920, the pumps being unable to handle the increased volume.

Additional equipment was installed and after unwatering the shaft, grouting was resorted to, in which 132 sacks of cement were pumped into the water bearing seams under a pressure of 200 lbs. This effectively sealed off the water and excavation was resumed.

A Gould triplex pump with a capacity of 275 gallons per minute was installed at the sump in the shaft, 260 ft. deep, as a part of the Groveland water supply.

Moccasin Creek Power Development:

As has been indicated heretofore in other reports, the first unit of power to be constructed will be that on Moccasin Creek, which will produce some 60,000 horse power.

Preliminary studies of this project have been completed and final plans and specifications are now in course of preparation. It has been determined to build a railroad spur from the Hetch Hetchy Railroad directly above the power house. This will provide adequate means of delivering the heavy materials used in the construction of the building and all of the hydraulic and electrical machinery. On account of the size of the units involved, parts of the equipment will be as heavy as can be transported on standard railway cars.

The plans call for three 20,000 K.V.A. generators, each directly connected to two overhung 12,500 H.P. 240 R.P.M. impulse wheels. These three units will consume, when run-

ning with a load factor of 85 per cent, 620 second feet of water; which quantity is the amount the aqueduct was designed to carry.

A definite location has been selected for the dam forming the Priest forebay reservoir, and plans for the construction of the dam core wall and wasteways are completed.

A careful study has been made to determine the proper location for the penstock lines connecting the reservoir with the power house. Together with these surveys, a careful study has been made to determine the economic sizes of pipes and tunnels to be employed.

All of the work in connection with the Moccasin Creek development is well advanced, insuring that there will be no delay between the time when the water is available and the commencement of power generation. This is desirable, due to the fact that at the present time there is a much greater demand for electric power in the State of California than can be supplied for a considerable number of years to come. There is also an annual increase in the demand for power amounting to between 50,000 and 60,000 K.W., which about equals the size of the proposed Moccasin Creek unit so that when this plant goes into commission it can only be considered as furnishing the means of supplying the increased demands of a twelve months' period. With this condition existing and the rate of demand increasing annually, there is no reason to fear for the ultimate result of the power undertaking in connection with the Hetch Hetchy water supply project.

Hetch Hetchy Railroad Operation:

Operation of the Hetch Hetchy Railroad has been continued throughout the year. Equipment and material have been hauled to the Hetch Hetchy damsite and to the various camps situated along the aqueduct.

Considerable local freight business has been developed and large quantities of lumber have been shipped from the



Hetch Hetchy Railroad. Type of gasoline motor truck operated in freight service.

California Peach Growers Association's sawmill at Mather. Two more sawmills have begun cutting and expect to ship lumber soon.

Request has been made by the mining interests operating around Stevens Bar for service, and consideration has been given to construction of a siding to handle shipments of mining timbers, concentrates, machinery, etc., near Stevens Bar bridge.

Other lumber prospects are in view, and it appears that sufficient of this business will be developed to warrant continuation of operation of the railroad after the Mountain Division of the project is completed.

Passenger traffic is handled principally by track motors. The combined auto and rail trip from Yosemite to Hetch Hetchy and return has become popular and will be further stimulated by the opening of Hetch Hetchy Lodge, a hotel now being erected by the Yosemite National Park Company at Mather.

The railroad will undoubtedly secure a portion of the tourist traffic to Yosemite Park. The scenery along this route compares favorably with the Canadian Pacific and Royal Gorge railroads, and has aroused the greatest enthusiasm from all who have taken the trip.

Railroad Construction:

Ballasting is still under way, about 50 miles having been completed. Gravel for the completion of the work is being obtained from a pit at Mather. The gravel deposit was overlaid by a stratum of silt and loam from four to eight feet thick, which involved the stripping of some 15,000 yards of material.

STATISTICS OF HETCH HETCHY WATER SUPPLY OF THE CITY AND COUNTY OF SAN FRANCISCO

I. HETCH HETCHY AND LAKE ELEANOR
RESERVOIRS

	Hetch Hetchy		Lake Eleanor	
	Initial	Ultimate	Present	Ultimate
Area of watershed, square miles.....	459	459	79	183*
Capacity of reservoir, millions of gallons.....	66,000	112,000	8,200†	54,000†
Acre-feet.....	202,000	343,000	25,300	167,600
Water surface area, acres.....	1,590	1,940	948	1,412
Square miles.....	2.5	3	1.5	2.2
Elevation of roadway on dam, feet.....	3,726.5	3,812	4,661	4,785
Elevation of spillway crest, feet.....	3,719.75	3,800	4,660‡	4,775
Length of reservoir, miles.....	7.5	8	3.1	3.2
Width of reservoir, maximum, miles.....	0.65	0.7	1.0	1.1
Width of reservoir, average, miles.....	0.33	0.38	0.5	0.7
Depth of reservoir from spillway crest:				
Maximum, feet.....	220	300	60†	175†
Average, feet.....	128	172	27†	119†
Dam:				
Type of dam.....	Concrete, gravity section, arched in plan		Reinforced concrete buttressed arch	
Total length on crest, feet.....			Rock fill with concrete facing	
Height of crest above stream level, feet.....	600	900	1,260	1,750
Depth from stream level to bedrock, at toe of dam, maximum, feet.....	226	312	60	185
Total height of dam, above bedrock, feet.....	(Roadway)		(Roadway)	
Width at top, feet.....	80	80	Stream bed is solid rock	
Width at base, maximum, feet.....	15	25		
Volume of masonry, cubic yards.....	310	310	Channel around end of dam	
Type of spillway.....	370,000	625,000		
	Siphon	Channel around end of dam	11,640	
Railway constructed, miles.....	68	68	Overflow	
Roads constructed, miles.....	5	5		around end of dam

*Includes Cherry watershed above proposed diversion.

†Lake Eleanor depths and capacities do not include original lake, which is not available for draft.

‡With flashboards in place; 4,655 without flashboards.

II. RESERVOIRS FOR FUTURE DEVELOPMENT

	Poopenaut Valley	Cherry Valley	Lake Vernon	Huckleberry Lake	Emigrant Lake
Area of watershed, square miles.....	473*	114†	40‡	17†	11†
Capacity of reservoir:					
Millions of gallons.....	10,000	18,500	16,600	17,000	4,600
Acre-feet	31,000	57,000	51,000	52,200	14,250
Water surface area:					
Acres	383	1,150	640	800	320
Squares miles	0.6	1.8	1.0	1.25	0.5
Elevation of spillway crest, feet.....	3,468.5	4,550	6,630	7,700	8,700
Length of reservoir, miles.....	2.3	3.4	2	4	2
Width of reservoir:					
Maximum, miles	0.55	0.8	0.7	0.5	0.3
Average, miles	0.45	0.53	0.5	0.3	0.25
Depth of reservoir:					
Maximum, feet	160	150	105	100	60
Average, feet	81	50	80	65	45
Type of dam.....	{ Concrete gravity section		Rock fill or Eleanor type	Rock fill	Rock fill
Length of dam, feet.....	370	1,060	2,000	520	420

*Includes Hetch Hetchy watershed.

†Cherry Valley watershed includes watersheds of Huckleberry and Emigrant Lakes.

‡Included in Hetch Hetchy watershed.

III. POWER DEVELOPMENT POSSIBILITIES

	Existing Plant		Proposed Plants	
	Early Intake	Moccasin Creek	Early Intake	North Mountain
Location of plant.....	Cherry River	Hetch Hetchy Reservoir	Pressure tunnel	Canal and tunnel
Source of water supply.....	Flume, canal and tunnel	Pressure tunnel	Pressure tunnel	Canal and tunnel
Aqueduct, type	3.3	19.5	11	7.6
Aqueduct length, miles (not including pressure pipes)	200	620	620	200
Aqueduct capacity, sec. ft.....	Large flume	Reservoir		
Forebay, type				
Forebay capacity:				
Gallons	1,500,000	815,000,000		
Acre-feet	4.6	2,500		
Pressure pipes:				
Length, feet	530	4,345	2,500	5,700
Number of pipes.....	1	3		
Diameter of pipes.....	3' 6"			
Gross drop, feet.....	345	1,300	1,100	2,000
Power plant:				
24-hr. average capacity—				
K. W.	3,000	52,500	42,000	24,000
H. P.	4,000	70,000	56,000	32,000
Number of generators.....	3	3		
Capacity each machine, K. W.....	1,100	17,500		
Total installed capacity—				
K. W.	3,300	52,500		
H. P.	4,400	70,000		

Note—Development of Huckleberry and Emigrant Lakes as reservoirs will make available additional power, the amount of which has not yet been determined.

EXPENDITURES ON HETCH HETCHY PROJECT**For Fiscal Year Ending June 30, 1920****WATER CONSTRUCTION**

Acct. No.	Title	Amount
2001	Preliminary water supply investigations, credit.....\$	160.92
2002	Land, water rights and rights of way.....	136,128.41
3	Rentals to U. S. Government.....	15,000.00
4	Legal expenses	12,919.71
5	Hydrography	3,449.93
6	City office administration.....	35,847.65
7	City office engineering.....	39,068.02
8	State compensation insurance.....	36,573.58
9	Taxes	5,841.49
12	Unamortized discount on securities and expenses.....	13,589.71
2101	Groveland office administration and engineering.....	23,096.68
2	Hospital buildings and equipment.....	2,724.77
4	Hospital operating expenses.....	11,493.16
10	Groveland dwellings	19,115.87
11	Groveland warehouse	2,554.49
12	Groveland permanent water supply.....	5,297.46
2202	H. H. engineering.....	10,881.03
3	H. H. camps.....	15,384.88
5	H. H. dam and appurtenances.....	35,853.83
5	H. H. dam and appurtenances, contract Utah. C. Co.	195,376.67
6	H. H. clearing, dam and appurtenances.....	
8	H. H. dam and appurt., contract Coffin Valve Co.....	57.60
26	H. H. telegraph and telephone lines.....	2,899.88
27	H. H. camp maintenance.....	468.44

Aqueduct Tunnels:

2401	Preliminary investigations and surveys.....	83.65
2	Engineering	10,620.19
3	Camps	12,403.95
4	Roads, trails and tramways.....	2,804.19
6	Shafts	117,241.55
7	Tunnel construction	395,878.46
8	Early Intake C. & C. Aqueduct.....	5,982.99
26	Telegraph and telephone lines.....	1,675.02
27	Camp Maintenance	2,384.45
07	Contract 77-C, contractor's fee.....	276,776.40
07	Contract 77-C, payrolls, M&S, etc.....	63,245.26
3003	Mather Sawmill camps.....	12,376.56
5	Mather Sawmill, sawmill and equipment.....	20,076.96
26	Mather Sawmill telegraph and telephone.....	23.75
27	Mather Sawmill camp maintenance	213.20
70	Mather Sawmill operating expenses.....	36,647.68
3501	Golden Rock Ditch, operating expenses.....	4,740.79
4000	Boarding house	178,409.54
5000	Materials and supplies.....	221,270.89

Total\$1,986,317.82

Credit

Account of sales of material, refunds, etc.:

Acct. No.		
2008	State compensation insurance.....	\$ 2,746.98
2203	H. H. camps.....	5,179.86
2205	“ Dam and appurtenances.....	20,252.56
2206	“ Clearing reservoir	440.00
2407	A. T. M. D., tunnel construction.....	1,034.56
3005	Sawmill and equipment.....	1.20
4000	Boarding house	2,037.56
5000	Materials and supplies.....	3,757.82
		<hr/> 35,450.54

Net expenditures, water construction \$1,950,867.28

Receipts from Various Sources

Acct. No.		
2002	Rentals from Crocker Amazon Tract.....	\$ 337.50
2103	Groveland Hospital revenue.....	7,592.50
2109	Groveland dwellings revenue.....	937.00
3040	Mather Sawmill	16,198.82
3500	Golden Rock Ditch.....	483.98
4000	Boarding house	133,840.55
		<hr/> \$ 159,389.35

Total receipts, Water Construction.... \$ 159,389.35

Acct. No.	Title	Amount
2301	Lake Eleanor, preliminary surveys and investigations....	\$ 3,801.49
2	“ “ Engineering	148.56
3	“ “ Camps	1,417.23
4	“ “ Roads, trails and tramways.....	4,042.08
5	“ “ Dam and appurtenances.....	491.57
6	“ “ Clearing reservoir	15,820.19
26	“ “ Telegraph and telephone lines.....	16.61
27	“ “ Camps	1.15
2502	Priest, Engineering	14.50
3	“ Camps	294.99
6	“ Clearing reservoir	41.25
2601	Moccasin Creek, preliminary surveys & investigations..	1,968.90
7	Moccasin Creek, plant buildings and equipment.....	3.05
2802	L.C.P.D., Engineering	2,193.44
3	“ Camps	469.84
5	“ Land for electrical purposes.....	300.00
6	“ Penstock	1,089.60
7	“ Power plant, buildings and structures.....	2,067.09
8	“ Power plant, hydraulic equipment	2,273.72
13	“ Power plant, miscellaneous equipment.....	22.90
14	“ Transmission line, poles and fixtures.....	9,288.80
15	“ Transmission line, overhead construction.....	3,184.18
16	“ Transmission line, clearing line.....	1,551.52
17	“ Transmission line, subst'n bldgs. & equipment	127.05
18	“ Transmission line, subst'n equipment.....	2,004.60
19	“ Transmission line, miscellaneous equipment....	185.46
20	“ Transmission line, transformers and devices....	487.47
22	“ Meters	44.10

L.C.P.D.,	26	Telegraph and telephone lines.....	627.82
70	"	Operating expenses	17,956.26
27	"	Camp maintenance	33.23
Total.....			\$71,968.65

Credit

From sales of material, refunds, etc.:

2306	L. E.,	clearing reservoir.....	\$26.50
2820	L.C.P.D.,	transm. line, transformers & devices....	80.01
2870	"	Operating expenses	18.75
			125.26

Net expenditures, power construction.....	\$71,843.39
---	-------------

Receipts from sale of power.....	\$68,338.72
----------------------------------	-------------

HETCH HETCHY RAILROAD

Investment account, additions and betterments.....	\$442,826.96
" " material and supplies	27,728.19

Total, investment account	\$470,555.13
Operating expenses	192,356.14

Total railroad expenditures.....	\$662,911.27
----------------------------------	--------------

Receipts from Railroad Operations

Freight receipts	\$ 56,453.53
Passenger receipts	15,992.78
Miscellaneous	962.25

Total receipts, Railroad Operations.....	\$ 73,408.56
--	--------------

NOTE:—In addition to the foregoing receipts the railroad performed services for water and power construction based on tariff rates and fares valued as follows:

Freight service	\$21,868.15
Passenger service.....	6,899.83
Total.....	\$ 28,767.98

The value of this service has not been set forth in report to the Railroad Commission for the reason that it has no **revenue** basis, and has been absorbed through the operating expense.

SUMMARY OF EXPENDITURES ON HETCH HETCHY WATER SUPPLY

Expenditures

Water Construction	\$1,950,867.28	
Power Construction	71,843.39	
Railroad Construction and Operation.....	662,911.27	
	<hr/>	\$2,685,621.94

Receipts

Water Construction	\$ 159,389.35	
Sale of Power.....	68,338.72	
*Railroad Operations	73,408.56	
	<hr/>	301,136.63
Net expenditures for 1919-1920.....		\$2,384,485.31
Net expenditures previous to July 1, 1919.....		7,343,132 85
		<hr/>
Total expenditures to date (July 1, 1920).....		\$9,727,618.16

*See note above.

AMOUNT AND COST OF STREET WORK—PRIVATE

Fiscal Year Ending June 30, 1920

Asphalt, 6" concrete base		
Wearing surface 2".....	2,030.52 sq. yds.	\$ 4,590.11
Wearing surface 1", binder 1½".....	663.33 " "	2,268.60
Wearing surface 2", binder 1½".....	432.82 " "	923.20
Asphaltic Concrete, 6" concrete base		
Wearing surface 1½" paint coat.....	18,363.61 " "	47,371.05
Concrete Pavement 6".....	11,159.78 " "	32,846.16
Asphalt with vitrified brick strip		
Wearing surface 2".....	617.29 " "	1,333.34
Vertical fibre brick.....	720.17 " "	2,462.97
Asphaltic Concrete with vitrified brick strip		
Wearing surface 1½", paint coat, 6" concrete base.....	648.84 " "	1,518.29
Vertical fibre brick.....	771.63 " "	3,125.12
Curbs		
Granite (new)	410.01 ft.	698.27
Granite (reset)	411.15 " "	83.89
Granite (redress and reset).....	94.40 " "	47.20
Concrete	18,406.63 " "	16,895.24
Wheel Guard		
Concrete	310.00 " "	217.00
Artificial Stone Sidewalks.....	679.40 sq. yds.	996.11
Grading		
Cut	11,012.89 cu. yds.	14,161.26
Fill	1,243.60 " "	1,448.66
I. S. P. Sewer		
8"	4,216.82 ft.	15,431.25
8" Y's.....	296	505.25
12"	3,041.97 ft.	10,949.75
12" Y's.....	126	263.25
15"	1,408.86 ft.	5,251.23
15" Y's.....	51	143.00
18"	536.96 ft.	2,878.00
18" Y's.....	12	34.00
Manholes (new).....	46	5,405.00
Lamphole	1	40.00
Catchbasins		
New	26	2,817.24
Reset	2	100.00
Inlet	1	75.00
Culverts		
8"	3.00 ft.	4.50
10"	657.50 " "	1,056.07
Total.....		\$175,940.00

AMOUNT AND COST OF STREET WORK—PUBLIC

Fiscal Year Ending June 30, 1920

Asphalt, 6" concrete base		
Wearing surface 2".....	45,860.34 sq. yds.	\$ 95,318.43
Wearing surface 2½".....	257.50 " "	602.55
Wearing surface 2", binder 1½".....	2,957.63 " "	7,534.08
Asphaltic concrete, 6" concrete base		
Wearing surface 1½", paint coat.....	36,588.46 " "	81,753.13
Vitrified Brick		
Vertical fibre	2,480.81 " "	10,023.64
Hillside	1,166.03 " "	4,653.75
Asphalt with vitrified brick strip		
Wearing surface 2".....	9,571.03 " "	20,312.79
Vertical fibre brick.....	2,049.70 " "	8,049.92
Hillside brick	1,600.21 " "	7,052.61
Wearing surface 2½".....	903.93 " "	2,359.25
Hillside	277.04 " "	1,221.77
Asphaltic Concrete with vitrified brick strip		
Wearing surface 1½", paint coat, 6" concrete base.....	3,872.28 " "	8,804.72
Vertical fibre brick.....	1,088.89 " "	5,180.00
Hillside	925.00 " "	4,978.35
Curbs		
Granite (new).....	4,529.70 ft.	6,613.57
Granite (reset).....	1,602.45 " "	446.97
Concrete (new).....	41,998.65 " "	34,793.28
Concrete (reconstructed).....	28.00 " "	25.20
Concrete (relaid).....	8.25 " "	4.12
Gutters, vitrified brick	828.67 sq. yds.	4,217.46
Artificial Stone Sidewalks	9,679.74 " "	14,182.88
Grading		
Cut	40,366.22 cu. yds.	39,086.77
Fill	5,252.25 " "	1,225.34
I. S. P. Sewers		
8"	2,735.11 ft.	5,139.22
8" Y's.....	148	211.45
10"	401.90 ft.	622.95
10" Y's.....	15	28.20
12"	2,916.65 ft.	6,309.35
12" Y's.....	103	164.10
15"	249.50 ft.	867.13
15" Y's.....	4	10.00
18"	362.72 ft.	1,468.96
18" Y's.....	5	27.00
Manholes	39	3,643.00
Catchbasins		
New	101	10,449.50
Reset	3	128.22
Culverts, 10" I. S. P.	2,482.25 ft.	3,305.55
Total		\$390,815.47

AMOUNT AND COST OF STREET WORK—CITY PAY**Fiscal Year Ending June 30, 1920**

Asphalt		
Wearing surface 2", 6" conc. base.....	107.51 sq. yds.	\$ 215.19
Wearing surface 2", rolled rock base.....	32,888.00 " "	23,883.37
Asphaltic Concrete		
Wearing surface 1½", paint coat, 6" concrete base.....	43,393.38 " "	84,865.08
Asphaltic Concrete with vitrified brick strip		
Wearing surface 1½", paint coat, 6" concrete base.....	2,352.21 " "	4,657.38
Vertical fibre brick.....	941.90 " "	3,475.50
Paint Coat	30,010.00 " "	791.36
Binder	994.00 tons	6,961.50
Curbs		
Granite, reset	79.45 ft.	13.86
Concrete	2,378.81 " "	2,251.89
Header, redwood	12,197.04 " "	1,342.06
Gutters, concrete	336.89 sq. yds.	1,368.80
Artificial Stone Sidewalks	237.22 " "	298.90
Grading		
Cut	23,581.60 cu. yds.	15,839.78
Fill	854.00 " "	1,115.40
I. S. P. Sewers		
8"	260.25 ft.	247.24
12"	57.50 " "	200.75
15"	443.00 " "	888.20
15" Y's.....	15	15.00
18"	225.00 " "	337.50
18" Y's.....	4	4.00
Tile Drain 4"		227.89
Manholes (new)	9	860.00
Catchbasins		
New	11	1,035.00
Special type	8	1,200.00
Inlets	4	360.00
Culverts		
8" I. S. P.....	4.50 ft.	6.75
10" I. S. P.....	1,156.80 " "	1,521.44
Miscellaneous extras		386.08
Total City pay		\$153,869.92

SUMMARY**COST OF STREET WORK.**

Private	\$175,940.00
Public	390,815.47
City pay	153,869.92
Total	\$720,625.39

CONSTRUCTION COSTS
and QUANTITIES
OF
Principal Boulevards
OF
SAN FRANCISCO

1920

CONSTRUCTION COSTS AND QUANTITIES OF PRINCIPAL BOULEVARDS OF SAN FRANCISCO

(Widths given are of paved sections)

Junipero Serra Boulevard from Ocean Avenue to County Line:

1914. Contractor, City Street Improvement Company.
Length, 8,308 ft.; width, 25 ft.
Cost of construction, \$53,340.05.
Appropriations: Budget, \$52,000.00; County Roads fund, \$2,609.45.
Type of pavement, 1" asphalt, 1½" binder, 6" concrete base.
Asphalt, 212,968 sq. ft.
Concrete gutter, 41,581 sq. ft.
I. S. P. culvert, 571 ft.
Corrugated iron culvert, 132 ft.

Sloat Boulevard from Great Highway to Ocean Avenue:

1915. Contractor, Blanchard-Brown Company.
Length, 11,405 ft.; width, 30 ft.
Cost of construction, \$60,767.59.
Appropriations: County Roads fund, \$33,007.39; S. V. W. Co. and
U. R. R., \$30,000.00.
Type of pavement, 1" asphalt, 1½" binder, 6" concrete base.
Asphalt, 350,614 sq. ft.
Concrete curb, 199 ft.
I. S. P. culvert, 90 ft.
Fill, 1200 cu. yds.

Portola Drive from Stanford Heights to Sloat Boulevard:

1915-16. Contractor, H. G. Vaughn.
Length, 6,811 ft.; width, 40 ft.
Cost of construction, \$46,975.33.
Appropriation: County Roads fund, \$22,972.13; property owners,
\$25,608.00.
Type of pavement, 1" asphalt, 1½" binder, 6" concrete base.
Asphalt, 299,343 sq. ft.
Fill, 212 cu. yds.

Camino del Mar from Presidio to Lincoln Park:

1915. Contractor, John Brickell Company, City Street Improvement Company.
Length, 1,665 ft.; width, 50 ft. and 40 ft.
Cost of construction, \$55,556.53.
Appropriations: Panama Pacific Exposition, \$56,000.00.
Type of pavement, 1" asphalt, 1½" binder, 6" concrete base.
Asphalt, 122,600 sq. ft.
Concrete walk, 29,246 sq. ft.
Concrete curb, 6,020 ft.
I. S. P. sewer, 3,005 ft.
Cut, 13,400 cu. yds.
Fill, 4,000 cu. yds.
Wooden culvert, 400 ft.

Twin Peaks Boulevard, Section A, from St. Germain Avenue through Twin Peaks Reservoir Site:

1915-16. Contractor, Eaton and Smith.
Length, 2,800 ft.; width, 25 ft.
Cost of construction, \$26,907.97.
Appropriations: General fund, 1914-15, \$28,000.00; County Roads fund, \$345.82.
Type of pavement, 1" asphalt, 1½" binder, 6" concrete base.
Asphalt, 65,462 sq. ft.
Asphalt on macadam, 5,004 sq. ft.
Corrugated iron culvert, 697 ft.
Cut, 29,273 cu. yds.

Twin Peaks Boulevard, Section B, from Corbett Avenue to Twin Peaks Reservoir Site:

1915-16. Contractor, F. R. Ritchie.
Length, 7,900 ft.; width, 25 ft.
Cost of construction, \$57,015.77.
Appropriation: County Roads fund, \$64,539.57.
Type of pavement, 1" asphalt, 1½" binder, 6" concrete base.
Asphalt, 202,121 sq. ft.
Cut, 59,741 cu. yds.
Corrugated iron culvert, 1,082 ft.
Fence, 9,000 ft.

Twin Peaks Boulevard, Section C, Burnett and Clarendon Avenues from St. Germain Avenue to Clayton Street:

1916-17. Contractor, Flinn & Treacy.
Length, 1,420 ft.; width, 25 ft.
Cost of construction, \$7,732.07.
Appropriation: County Roads fund, \$4,601.78; 1908 Fire Protection fund, \$648.00; property owners, balance.
Type of pavement, 2" asphaltic concrete, 6" concrete base.
Asphalt, 38,423 sq. ft.
Concrete gutter, 603 ft.
Cut, 1,344 cu. yds.

San Bruno Avenue from Vista to Bay Shore:

1915-16. Contractor, City Street Improvement Company.
Length, 2,725 ft.; width, 42 ft.
Cost of construction, \$39,859.63.
Appropriations: Budget, 1914-15, \$35,000.00; County Roads fund, \$8,736.25.
Type of pavement, 1" asphalt, 1½" binder, 6" concrete base.
Asphalt, 146,133 sq. ft.
Cut, 7,700 cu. yds.
Concrete curb, 5,900 ft.; redwood curb, 789 ft.
I. S. P. culvert, 589 ft.
I. S. P. sewer, 2,500 ft.

Corbett Avenue from Twenty-fourth Street to East Line San Miguel Rancho:

1916. Contractor, D. L. Bienfeld.
Length, 4,410 ft.; width, 20 ft.

Cost of construction, \$21,786.12.
Appropriation: County Roads fund, \$25,304.22.
Type of pavement, 1" asphalt, 1½" binder, 6" concrete base.
Asphalt, 100,496 sq. ft.
Fence, 7,498 ft.
Cut, 6,732 cu. yds.
Corrugated iron culvert, 505 ft.
I. S. P. drains, 1,387 ft.

Potrero Avenue from San Bruno to Twenty-fifth Street:

1916-17. Contractor, Eaton & Smith.
Length, 1,200 ft.
Cost of construction, \$35,546.94.
Appropriations: County Roads fund, \$37,832.31.
Type of pavement, 1" asphalt, 1½" binder, 6" concrete base.
Asphalt, 92,134 sq. ft.
Basalt block, 7,277 sq. ft.
Concrete walk, 6,566 sq. ft.
Granite curb, 2,286 ft.
Cut, 20,439 cu. yds.
Fill, 3,644 cu. yds.
I. S. P. culvert, 240 ft.
I. S. P. sewer, 365 ft.
Piling, 2,801 ft.
Sheathing, 16,392 ft.

Railroad Avenue from Hollister to San Bruno Avenue:

1916-17. Contractor, J. P. Holland.
Length, 4,300 ft.
Cost of construction, \$3,268.32.
Appropriation: County Roads fund, \$3,543.37.
Type of construction: Grading.
Cut, 8,188 cu. yds.

Railroad Avenue from Yosemite Avenue to Hollister Avenue:

1916-17. Contractor, Eaton & Smith.
Length, 2,100 ft.; width, 70 ft.
Cost of construction, \$32,114.40.
Appropriations: County Roads fund, \$1,751.36; property owners, balance.
Type of pavement, 2" asphalt, 6" concrete base.
Asphalt, 129,370 sq. ft.
Concrete walk, 3,442 sq. ft.
Granite curb, 4,168 ft.
I. S. P. culvert, 832 ft.
I. S. P. sewer, 3,006 ft.

Railroad Avenue from Ingerson Avenue to San Bruno Avenue:

1917. Contractor, James Smith.
Length, 1,923 ft.; width 70 ft.
Cost of construction, \$46,911.97.
Appropriations: County Roads fund, \$27,712.27; property owners, balance.

Type of construction: Basalt block on 6" concrete base.
Basalt, 102,448 sq. ft.
Basalt gutter, 7,596 ft.
Granite curb, 3,502 ft.
Concrete walk, 5,144 sq. ft.

Lobos Creek Viaduct:

1917. Contractor, Cahill, Vensano Company.
Length, 163 ft.
Cost of construction, \$9,151.50.
Appropriations: Budget, 1917-18, \$4,500.00, \$75.75; U. S. Government, balance.
Type of construction: Reinforced concrete viaduct.

HUNTERS POINT BOULEVARD:

Sec. A, Evans Avenue from Lane Street to Ingalls Street.
Sec. B, Evans Avenue and Ingalls Street to Hawes Street and Hudson Avenue.
Sec. C (Sewer), Hawes Street from Hudson Avenue to Innes Avenue.
Sec. D, Innes Avenue from Hawes Street to Donahue Street.
Sec. E, Donahue Street from Innes Avenue to Galvez Avenue, Galvez Avenue from Donahue Street to Coleman Street.
Sec. F, Galvez Avenue and Coleman Street to Fairfax Avenue and Boalt Street.
1917. Contractor, H. Crummey, Inc.
Length, 11,000 ft.; width, 60 ft.
Cost of construction, \$193,443.45.
Appropriations: County Roads fund, \$74,035.85; Bethlehem Steel Company, \$29,000.00; property owners, balance.
Type of pavement: Secs. A, D, E, 2" asphalt on 6" concrete base;
Secs. B, F, 2" Topeka on 6" concrete base.
Asphalt, 355,623 sq. ft.
Topeka, 125,352 sq. ft.
Concrete walk, 19,209 sq. ft.
Granite curb, 14,116 ft.
Cut, 89,730 cu. yds.
Fill, 48,510 cu. yds.
I. S. P. culvert, 1,482 ft.
I. S. P. sewer, 5,712 ft.
Concrete sewer, 170 ft.

Marina Boulevard—Grading from Laguna Street to Scott Street:

1917. Contractors, J. P. Holland, F. O'Shea.
Cost of construction, \$2,308.80.
Appropriation: County Roads fund, part of \$43,402.74.
Construction: Fill, 7,696 cu. yds.

Marina Boulevard—Sec. A, from Laguna Street to Steiner Street:

1918. Contractor, Felix McHugh.
Length, 2,200 ft.; width, 51 ft.
Cost of construction, \$35,839.54.
Appropriation: County Roads fund, part of \$43,402.74.
Type of pavement, 2" Topeka on 6" concrete base.
Topeka, 110,471 sq. ft.

Basalt, 975 sq. ft.
Brick gutters, 8,056 sq. ft.
Concrete walk, 33,774 sq. ft.
Concrete curb, 4,054 ft.
Cut, 1,926 cu. yds.
Fill, 3,073 cu. yds.
I. S. P. culvert, 735 ft.
I. S. P. sewer, 624 ft.

Army Street from San Bruno Avenue to Potrero Avenue:

1918. Contractor, Thos. Clark.
Length, 280 ft.; width, 32 ft.
Cost of construction, \$3,574.40.
Appropriation: County Roads fund, \$3,737.50.
Type of pavement, 2" asphalt on 6" concrete base.
Asphalt, 6,443 sq. ft.
Asphalt surface, 5,655 sq. ft.
Concrete walk, 421 sq. ft.
Granite curb, 691 ft.
Fill, 181 cu. yds.
I. S. P. culvert, 65 ft.

Army Street from San Bruno Avenue to Third Street:

1918. Contractor, J. P. Holland.
Cost of construction, \$12,348.40.
Appropriation: County Roads fund, \$14,135.40.
Construction: Grading.
Fill, 17,800 cu. yds.

St. Francis Circle and Sloat Boulevard:

1918-19. Contractor, Blanchard, Brown Company.
Cost of construction, \$21,357.56.
Appropriations: County Roads fund, \$22,000.00.
Type of construction, 1½" asphaltic concrete on 6" concrete base.
Asphalt, 56,088 sq. ft.
Asphalt surface, 2,000 sq. ft.
Basalt, 1,180 sq. ft.
Concrete walk, 8,282 sq. ft.
Concrete curb, 4,160 ft.
Fill, 4,796 cu. yds.

Great Highway from Sloat Boulevard to north end of Esplanade:

1919. Contractor, Blanchard, Crocker & Howell.
Length, 15,000 ft.; width—lower, 40 ft.; upper, 30 ft.
Cost of construction, \$80,221.46.
Appropriations: County Roads fund, \$85,000.00.
Type of construction: Lower road, type "A", 1½" asphaltic concrete on 6" concrete base; Upper road, type "B", 2" asphaltic concrete.
Type "A", 229,682 sq. ft; type "B", 305,878 sq. ft.
Redwood headers, 9,143 ft.
Concrete gutter, 650 ft.
I. S. P. culvert, 213 ft.

Parker Avenue from St. Rose's Avenue to McAllister Street:

1919. Contractor, Blanchard, Crocker & Howell.
Length, 1,662 ft.; width, 35 ft.
Cost of construction, \$32,617.60.
Appropriations: County Roads fund, \$35,064.37.
Type of construction, 1½" asphaltic concrete on 6" concrete base.
Asphalt, 58,255 sq. ft.
Brick, 8,477 sq. ft.
Concrete walk, 2,135 sq. ft.
Cut, 20,434 cu. yds.
Fill, 58,255 cu. yds.
Redwood headers, 3,054 ft.
Concrete curb, 246 ft.
I. S. P. sewer, 647 ft.
I. S. P. drain, 437 ft.

Market Street Extension from Collingwood Street to Ord Street:

1920. Contractor, Raich Improvement Company.
Length, 1,214 ft.; width, 74 ft.
Cost of construction, \$37,606.73.
Appropriation: County Roads fund, \$37,500.00.
Type of pavement, 1½" asphaltic concrete, 6" concrete base.
Asphalt, 84,227 sq. ft.
Concrete walk, 4,066 sq. ft.
Concrete curb, 2,024 ft.
Cut, 5,943 cu. yds.
Fill, 3,549 cu. yds.

Great Highway, Easterly Half, from Fulton Street to point 438 feet north of Balboa Street:

1920. Contractor, Fay Improvement Company.
Length, 1,900 ft.; width, 43 ft.
Cost of construction, \$14,417.96.
Appropriation: County Roads fund, \$15,000.00.
Type of pavement, 1½" asphaltic concrete, 6" concrete base.
Asphalt, 87,428 sq. ft.
Concrete curb, 1,701 ft.
Concrete gutter, 2,382 sq. ft.
Cut, 2,000 cu. yds.

County Roads Fund

FINANCIAL STATEMENT *and*

SEGREGATION *of*
DISBURSEMENTS

JUNE 30, 1920

COUNTY ROADS FUND

Financial Statement and Segregation of Disbursements, June 30, 1920

Closed Accounts

	Construction	Engineering and Miscel.	Lands, Damages Legal Expenses	Total
	\$			\$
Junipero Sorra Boulevard.....	2,609.45			2,609.45
Sloat Boulevard—				
Construction.....	60,767.59	\$ 1,614.80		62,782.39
Right of way.....			\$ 400.00	48,580.13
Portola Drive.....	46,975.33	1,604.80		25,304.22
Corbett Avenue, Twenty-fourth-San Miguel				
Construction.....	21,786.12	1,564.15		
Plans.....		1,503.95		
Land.....			450.00	
Twin Peaks Boulevard.....				64,539.57
Construction.....	57,015.77	5,248.25		
Plans.....		1,700.55		
Titles and abstracts.....			575.00	
Market Street Extension.....				15,874.45
Plans.....		999.45		
Grading (Tunnel R. W.).....	2,400.00			
Paving (Tunnel crossings).....	8,500.00			
Damages.....			3,975.00	
Pt. Lobos Avenue (Cliff House Road)—Clearing (park labor).....	2,484.43			2,484.43
Great Highway—Coping and parkway (park labor).....	2,498.75			2,498.75
Collingwood Street, 20th—22nd.....		402.10		402.10
Oakdale Avenue, San Bruno—Railroad.....	192.81			192.81
San Bruno, Cortland—Steuben.....	7,355.88			
San Bruno, Cortland—Steuben.....	1,393.75			
San Bruno, Buena Vista—Bay Shore.....	8,736.28			17,837.41
San Bruno, Oakdale—Cortland.....	351.50			

BUREAU OF ENGINEERING

97

	Construction	Engineering and Miscel.	Lands, Damages Legal Expenses	Total
Innes Avenue, Hawes-Fitch (s).....	433.20	.....	.....	433.20
Hawes, Hudson-Innes (g & s).....	4,689.15	290.75	.....	4,979.90
Hunters Point Boulevard.....	.....	.....	.....	74,035.84
Construction.....	61,739.63	1,135.45	.....	.....
Filling in lot.....	100.00	.....	.....	.....
Lands, etc.....	.....	.....	7,504.40	.....
Plans.....	.....	311.53	.....	.....
Preliminary expense.....	.....	700.00	.....	.....
Construction (by refunds to property owners).....	.....	.....	.....	.....
St. Germain Boulevard.....	2,544.83	.....	.....	1,451.22
Worcester Avenue, widening.....	1,449.97	1.25	2,200.00	2,200.00
Casselli and Falcon.....	2,882.10	.....	.....	.....
Casselli, Corbett-Falcon.....	1,500.00	.....	.....	4,382.10
Army Street, San Bruno-Potrero.....	.....	.....	.....	.....
Army and Andrew Crossing.....	36,503.51	1,328.80	.....	37,832.31
Potrero, Twenty-fifth-San Bruno.....	.....	.....	.....	.....
Army, San Bruno-Potrero.....	.....	.....	.....	3,737.30
Construction.....	3,574.40	162.90	.....	.....
Army Street, San Bruno-Third.....	.....	.....	.....	14,385.40
Construction.....	12,398.40	687.00	.....	.....
Land and damages.....	.....	.....	1,300.00	.....
Clarendon & Burnett.....	3,754.23	847.55	.....	4,601.78
Railroad Avenue.....	.....	.....	.....	33,622.72
“ Hollister-San Bruno (g).....	3,268.32	275.05	.....	.....
“ Ingerson-San Bruno.....	27,712.27	.....	.....	.....
“ Ingerson-Hollister.....	1,751.36	.....	.....	.....
“ Ingerson-Lane.....	615.72	.....	.....	.....
Sloat Boulevard, moving tracks.....	48,000.00	.....	.....	48,000.00

COUNTY ROAD FUND—Continued

	Construction	Engineering and Miscel.	Lands, Damages Legal Expenses	Total
Marina Boulevard	38,148.34	1,954.40	3,300.00	43,402.74
Circular and Sunnyside Avenues	1,887.17	.....	.....	1,887.17
Randall Street, Mission-S. P. right of way	1,403.26	.....	.....	1,403.26
Tenth Street, Potrero and Division Easement	.....	.....	2,000.00	2,000.00
Legal expenses, titles, appraisals	.....	.....	8,235.58	8,235.58
Roosevelt Boulevard, titles and legal expenses	.....	.....	1,593.17	1,593.17
Oakdale Avenue, San Bruno to Selby	677.81	.....	.....	677.81
Army Street, San Bruno to DeHaro	2,990.16	.....	.....	2,990.16
Great Highway, Sloat Boulevard to Esplanade	80,221.46	4,777.80	.....	84,999.26
San Jose, Circular, Diamond and Joost	7,065.00	934.85	.....	7,999.85
St. Francis Circle-Sloat Boulevard	20,634.30	1,884.40	.....	22,518.70
Parker Avenue, St. Rose's to McAllister	32,617.60	2,445.15	.....	35,062.75
Tenth Street, Division and Potrero Avenue	2,986.70	327.50	.....	3,314.20
Ocean Avenue, Mission to Onadago	2,252.45	.....	.....	2,252.45
Great Highway (E. 1/2), Fulton northerly	14,417.96	582.00	.....	14,999.96
Investigations and plans, boulevard extensions	.....	14,256.55	270.87	14,527.42
Miscellaneous—	\$641,286.96	\$ 47,540.98	\$ 31,804.02	\$720,631.96
*Liberty Bonds	.....	.....	.....	*100,000.00
Annual statement	.....	.....	.....	100.50
Advertising—State Road Bond	.....	.....	.....	2,003.29
Total closed accounts	.....	.....	.....	*822,735.75
*Transfer of Liberty Bonds to investment account	.....	.....	.....	100,000.00
Total expenditures	.....	.....	.....	*722,735.75

COUNTY ROADS FUND—Continued

June 30, 1920

Open Accounts

San Jose Avenue widening—

	Construction	Engineering Expenses	Lands, Damages Legal Expenses	Total
Architect plans	\$ 795.00	.....	\$ 795.00
Legal expenses	\$ 1,528.75	1,528.75
Lands and damages	25,259.00	25,259.00
Roosevelt Boulevard, lands, etc.....	42,497.80	42,497.80
Market Street Extension, lands, etc.....	46,960.67	46,960.67
Sloat Boulevard widening, lands, etc.....	1,700.00	1,700.00
Sloat Boulevard and Great Highway Improvement, plans.....	620.00	.....	620.00
Parking signs	685.89
Market Street Extension, Collingwood to Ord.....	\$ 685.89	.....	.....	685.89
Evans Avenue, Napoleon to Army	32,968.13	1,437.00	.....	34,405.13
Corbett Avenue, Hattie to Ord.....	9,370.80	.....	.....	9,370.80
Great Highway (E. ½), Lincoln to Fulton.....	44.00	.....	44.00
Joint Highway Commission.....	112.00	.....	112.00
	1,000.00	.....	1,000.00
	\$ 43,024.82	\$ 4,008.00	\$ 117,946.22	\$ 164,979.04
Construction expenses	Closed	Open	Totals
Engineering	\$641,286.96	\$ 43,024.82	\$ 684,311.78
Lands, damages, legal expenses.....	47,540.98	4,008.00	51,548.98
Miscellaneous	31,804.02	117,946.22	149,750.24
	2,103.79	.....	2,103.79
Total expenditures	\$ 722,735.75	\$ 164,979.04	\$ 887,714.79

COUNTY ROADS FUND—Continued

Appropriations to Open Accounts

San Jose Avenue widening—	
Architect plans	\$ 1,260.00
Legal expense	2,000.00
Lands and damages.....	25,260.00
Street improvement	6,684.00
Roosevelt Boulevard, lands.....	41,167.80
Market Street Extension, lands.....	55,187.00
Sloat Boulevard widening, lands.....	1,700.00
Sloat Boulevard and Great Highway Improvements, plans....	1,000.00
Parking signs	650.00
Market Street Extension, Collingwood to Ord Street.....	37,500.00
Evans Avenue, Napoleon to Army Street.....	10,000.00
Corbett Avenue, Hattie to Ord Street.....	1,900.00
Great Highway (E. ½), Lincoln Way to Fulton Street.....	37,000.00
Joint Highway Commission.....	1,000.00
Sloat Boulevard, Great Highway to Fortieth Avenue.....	24,500.00
Corbett Avenue, Casselli to Twenty-third Street.....	10,000.00
Total appropriations	\$256,808.80
Expended from appropriations.....	164,979.04
Unexpended from appropriations.....	\$ 91,829.76
*Corbett Avenue appropriation.....	\$10,000.00
*San Jose Avenue street improvement.....	6,684.00
	<hr/> 16,684.00
Predicated by contracts.....	\$ 75,145.76
*Appropriations for Corbett Avenue and San Jose Avenue improve- ment are not predicated by any contract or liability.	

COUNTY ROADS FUND—Continued

Receipts

From appropriations by city—

Budget 1913-14.....	\$ 500.00
“ 1914-15.....	50,000.00
“ 1915-16.....	10,000.00
“ 1916-17.....	1,000.00
“ 1917-18.....	50,000.00
“ 1918-19.....	1,000.00
“ 1919-20.....	1,000.00

 \$ 113,500.00

From State of California appropriations—

October, 1914	55,304.87
March, 1915	6,472.15
August, 1915	103,820.71
April, 1916	8,302.30
September, 1916	104,482.39
February, 1917	7,355.46
August, 1917	132,794.64
February, 1918	5,672.70
September, 1918	150,592.98
March, 1919	2,419.26
August, 1919	191,882.08
January, 1920	12,133.99

 781,233.53

From other sources—

Refund of auto licenses by State, 1914....	\$ 358.00
Do., 1915-16-17	1,098.60
For construction of Portola Drive, etc., from S. V. W. Co., U. R. R., Forest Hill Realty, etc.	55,608.00
For improvement of San Bruno Avenue from S. P. Co.	1,249.63
Refund by Eaton & Smith, account Rail- road Avenue	763.95
Pacific Gas & Electric Co., Marina Blvd.	329.44
Interest on Liberty Bonds.....	5,344.31
By sale of clay from Parker Avenue to Golden Gate Park.....	1,432.00
Transfer from Budget 1919-20 for Evans Avenue grading	6,743.00
Transfer from Investment Account No. 2 for Liberty Bonds.....	100,000.00

 172,926.93

Total.....	\$1,067,660.46
By transfer of Liberty Bonds.....	100,000.00

Total receipts	\$ 967,660.46
Total expenditures	887,714.79

Assets	\$ 79,945.67
Liabilities	75,145.76

Net balance	\$ 4,799.91
-------------------	-------------

CONTENTS

	Page
LETTER OF TRANSMITTAL.....	1
BOULEVARDS, STREETS AND HIGHWAYS.....	7
SEWER SYSTEM	16
MISCELLANEOUS CONSTRUCTION:—	
Army Street and Evans Avenue Improvement.....	20
Public Comfort Station at Ocean Beach.....	23
Third Street Bridge Fender Piling.....	26
PROJECTS:—	
Rincon Hill Regrade.....	27
Aquatic Park	33
City Planning	37
Marin-San Francisco Bridge.....	38
Special Improvements	38
United States Pacific Coast Naval Base.....	39
MUNICIPAL RAILWAYS	41
SURVEYS	50
HETCH HETCHY WATER SUPPLY:—	
Housing Conditions	52
Boarding House	52
Hospital	53
Warehouses	53
Groveland Shops	54
Groveland Water Supply.....	54
Lake Eleanor Dam and Reservoir.....	54
Lower Cherry Power Development.....	55
Hetch Hetchy Dam.....	56
Work Accomplished under Contract.....	57
City Sawmill	67
Aqueduct Tunnel:—	
Cost-plus-fee contract	68
Priest Portal	70
Big Creek	72
South Fork	72
Early Intake	72
Second Garrotte Shaft.....	73

	Page
Moccasin Creek Power Development.....	73
Hetch Hetchy Railroad:—	
Operation	74
Construction	76

LIST OF ILLUSTRATIONS AND MAPS.

GREAT HIGHWAY AND OCEAN BEACH ESPLANADE:—	
Winter Scene	Frontispiece
MARKET ST. EXTENSION, INTERSECTION OF FALCON AVE., GRAND VIEW AVE., STANTON ST., YUKON ST., GLENDALE ST.—	
Clay Model Showing Proposed Treatment.....	11
Existing Conditions	12
BOULEVARD SYSTEM OF SAN FRANCISCO—MAP (Insert)	14
PRESIDIO RESERVATION SEWER DURING CONSTRUCTION	18
ARMY STREET RETAINING WALL.....	21
COMFORT STATION AT OCEAN BEACH:—	
Interior View	24
Sectional Plan	25
RINCON HILL DISTRICT—MAP.....	27
RINCON HILL REGRADE:—	
Harrison Street West from Spear Street.....	28
Harrison Street West from Essex Street.....	29
Harrison Street East and West of Second Street.....	30
Harrison Street East from Third Street	31
AQUATIC PARK:—	
View of Existing Cove.....	34
Plan of Improvement Submitted in Contest.....	35
Plan of Improvement Submitted in Contest.....	36
MUNICIPAL RAILWAY LINES OF SAN FRANCISCO—MAP....	40
MUNICIPAL RAILWAY:—	
Switching Tower at Spear and Market Streets.....	42
Presidio Terminal	47
VALVES FOR HETCH HETCHY DAM UNDER CONSTRUCTION IN CRAMP SHIPBUILDING PLANT.....	58

	Page
60-INCH BALANCED VALVE FOR HETCH HETCHY DAM:—	
Discharge End	59
Interior View	60
36-INCH BALANCED VALVE FOR HETCH HETCHY DAM:—	
Plug in Closed Position.....	61
HETCH HETCHY WATER SUPPLY:—	
Excavating Main Dam Foundation.....	66
Armstrong "Shoveloder" in Big Creek Tunnel Heading.....	71
HETCH HETCHY RAILROAD:—	
Gasoline Motor Truck.....	75

TABLES.

CURRENT CONTRACT DATA.....(Insert)	26
MUNICIPAL RAILWAY EARNINGS—COMPARATIVE TABLE	49
RECORD OF BIDS RECEIVED FOR CONSTRUCTION OF HETCH HETCHY AQUEDUCT TUNNELS.....(Insert)	70
STATISTICS OF HETCH HETCHY AND ELEANOR RESER- VOIRS STORAGE AND POWER.....	77
HETCH HETCHY PROJECT—EXPENDITURES.....	80
STREET WORK—AMOUNT AND COST.....	84
PRINCIPAL BOULEVARDS OF SAN FRANCISCO — COSTS AND QUANTITIES	87
COUNTY ROADS FUND—FINANCIAL STATEMENT AND SEGREGATION OF DISBURSEMENTS.....	95

